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# FOREST RESEARCH IN INDIA,

## 1935-36.

### PART I.—THE FOREST RESEARCH INSTITUTE.

#### CHAPTER I.—GENERAL REVIEW.

Work was continued in accordance with the sanctioned programme. A large number of day to day enquiries which were received during the year were also attended to.

A detailed programme of work in each of the Branches for the three years 1936-39 was drawn up at the Institute and sent to the provinces for suggestions. This programme, as finally approved, has been sent to Press since the close of the year. Every effort has been made to include problems of most importance to the Forest departments in the provinces and thus to maintain the closest co-operation with them. It is hardly necessary to emphasize again, as was done by the Board of Forestry, that advancement of Forestry in India depended to a very large extent on the co-operation between the Provinces and the Forest Research Institute.

During the year His Excellency the Governor of the United Provinces and the Hon'ble Sir Girja Shankar Bajpai visited the Institute. There was a large number of other visitors also and it might be mentioned that the representatives of the Gramophone Co., Ltd., Dum Dum, who also paid a visit acknowledged their appreciation of the valuable advice and assistance given and stated that they came away with a great deal of information which they felt sure would be of great use to them in the manufacture of gramophone and wireless cabinets.

*Silvicultural Branch.*—Experimental work at Dehra Dun has been seriously set back by repeated frost damage drawing additional attention to the fact that frost is clearly a factor which must be taken into account in forest management in this part of the country. Useful progress, however, continues to be made in several lines, especially on the subject of thinning investigations and the connected question of the practicability and advisability of pruning in plantations.

The regeneration and management of moist tropical forests continues to receive special attention. This is a subject which can only be studied on tour in collaboration with Provincial research and territorial officers

but in which there is room and demand for progress. The Silviculturist made an unofficial visit to Malaya in this connection.

The Statistical staff was largely occupied in routine work which included the compilation and publication of stand tables for *chir* pine and volume tables for *sissu* which should be useful in several provinces. The subject of thickness of sapwood and its rate of conversion to hardwood has come into prominence of late and a special study was made on deodar during the year.

A start has been made on the much needed modern text-book on Indian Silviculture and Silvicultural Systems. The chapters on the latter subject have been completed by the Inspector General of Forests, and the Silviculturist expects to complete the rest by October 1936.

*Botanical Branch.*—The study of the Indian species of *Terminalia* of the section *Pentaptera* has been completed and a draft report with illustrations is in the course of preparation. The systematic study of the *Dipterocarpaceae* was also continued during the year. A paper on some Indian and Burmese *Dilleniaceae* was published and a paper on a new genus of the *Connaraceae* was completed and sent for publication. Two further papers, one on the genus *Psilotum* in India and another dealing with recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain were published.

During the year 2,636 specimens received from various sources were incorporated in the herbarium and 689 specimens were distributed to various herbaria on an exchange basis. An increasingly large number of specimens (1629) sent in by forest officers and others from all over India were identified and advice on technical botanical matters given. Numerous additions were made to the Botanical Garden and the Arboretum both of which are making good progress. As usual considerable quantities of seed have been supplied to enquirers and institutions in various parts of the world.

The draft report on the work done during the last few years in connection with the investigation on the *shisham* root disease in the Punjab plantations and in the forests of the United Provinces has been completed. The problem of the *Gmelina arborea* die-back disease in the New Forest area has been investigated. *Gmelina arborea* plants have been inoculated with a *Coniothecium* sp., isolated from the diseased shoots of the plants with no useful results. Much progress has been made in the investigation of various parasitic rusts. Investigation of *Peridermium himalayense* on the stem of *Pinus longifolia* has been completed. A large number of inoculation experiments have been conducted in connection with the investigations on various other rusts on coniferous and broad-leaved species. Studies in connection with the wood-rotting properties and pathogenic behaviour of fungi occur-

ing on important timber trees have been continued and numerous inoculation experiments done on pines and deodar in the Chakrata forests.

*Entomological Branch.*—The investigation of the seasonal history of the *champ* bug, *Urostylis punctigera*, was completed and a cheap and simple method of control by spraying was devised for immediate application in plantations in North Bengal.

The biology of 161 species of hymenopterous and dipterous parasites was published as a first step in the utilisation of these natural agencies in the biological control of insect pests.

Successful work was done on the prevention of borer attack in newly felled logs and converted timber. The pests of plywood factories were investigated and remedies were found which enable the Indian made tea chest to be put on the market with a guarantee of immunity from borer damage.

*Economic Branch.*—The teak grading rules prepared during the previous year were issued in the form of a small pocket-book early in 1936 and it now remains to be seen whether the buyers and sellers of teak squares will profit by this new venture and will give the rules a fair trial.

Considerable progress was made during the year under review with the exploitation of the new wood preservative Ascu. The North Western Railway had 10,000 softwood sleepers treated with the preservative for a durability trial. The total cost of the treatment (including an extra anti-splitting treatment, depreciation, handling and labour charges) amounted to 7 annas 4 pies per B. G. sleeper. The corresponding cost of their present creosote-crude oil treatment is just over 1 rupee, so that a saving of 50 per cent at least can be anticipated if the new treatment is adopted.

A most welcome advance was also seen in the use of treated wooden poles for hydro-electric transmission lines. Several Indian States were also interested in the possibility of extending the uses of wood by using Ascu, and some have already installed and started to use the new type of pressure plant designed by the Forest Research Institute.

Six Ascu pressure plants came into operation during the year and at least 10 others will be in operation in different parts of India during the next few months.

Another important feature of the year's work was the establishment of definite relations between the Forest Research Institute and the paper mills of India. The paper mills have now allotted to Dehra Dun certain definite items of research and have shown their appreciation of the work being done in the Paper Pulp Section by subscribing to the funds of the Institute. This gesture on the part of the mills is much appreciated

and is indicative of a closer co-operation between research officers and the trade which will, it is hoped, be followed in other spheres.

The Seasoning Section made steady progress with the improvement of the new furnace kiln and it is now possible to say that a kiln of this type can be built in this country for less than Rs. 2,000 and since the kiln is easy to operate and cheap to run it is expected that it will be popular with small cabinet and furniture makers. The Seasoning Section also evolved a new type of electric moisture metre which can be made for about Rs. 150 against imported instruments of this kind which usually cost Rs. 800 or more.

The Forest Economist toured in Calcutta in January 1936. One of the main objects of the tour was to try and persuade some firm to start a plywood mill in Calcutta. The returns will probably be small to start with, but it is beyond question that plywood is foremost amongst the most popular constructional materials of the present day and that any one making a sound beginning now will reap the benefit in ample measure in the not far distant future.

*Chemical Branch.*—During the year under report the work on the examination of *Derris* species and other plants likely to have insecticidal properties was continued. Analysis of further sample of *Derris elliptica* from different localities of Assam showed that *Derris* roots of average quality, containing about 2.5 per cent. of rotenone, the active principle, are available in certain areas of that province. To establish a regular trade in this important insecticide the present supply from naturally growing *Derris elliptica* will have to be considerably increased by cultivation of suitable strain in localities where this species is indigenous. Search for rotenone and allied insecticidal bodies in other species of plants, has not met with success. Enquiries were made regarding commercial possibilities and probable demand for *Laurinacea* fat as a source of lauric acid which is in considerable demand on account of its being used in the preparation of sodium lauryl sulphate, a new type of detergent superior to ordinary soap in many respects. The replies received showed that there is a ready market for it, one firm expressed the opinion that their demand would be about 5 to 10 tons of the fat per month. Enquiries have been instituted to ascertain how much of the seeds of *Actinodaphne* and *Litsaca* species are at present available and how the present supply can be augmented. A glucoside has been isolated from the leaves of *Vitex negundo* which is probably responsible for the physiological properties of the leaves. Its pharmacology is being studied.

Mr. C. G. Trevor was deputed by the Government of India to attend the British Empire Forestry Conference in South Africa and during his absence Dr. Beeson was in charge of the current duties of the Inspector General of Forests and President.

## CHAPTER II.—SILVICULTURE BRANCH.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) GENERAL.

The following publications dealing with Experimental results obtained at the New Forest were published during 1935-36 :—

1. *A stand table for sal evenaged high forest and coppice.*
2. *Damage by Frost at New Forest.*

Preliminary Survey of the Forest Types of India and Burma has been passed and should appear very shortly.

The revision of Forest Bulletin No. 41 ("A note on the weights of seeds") has not yet been issued as it has been considered advisable to include additional information necessitating extensive revision of the draft prepared last year.

#### (ii) NATURAL REGENERATION.

The study of annual seed production and fertility of individual *Anogeissus latifolia* trees (Experiment No. 44) was continued for the 3th year. All trees except one produced a good crop of seed.

Seed crop from individual trees of *Shorea robusta*, *Terminalia tomentosa* and *Pinus longifolia* were also recorded. This was a good seed year for *Shorea robusta* but the other two species produced very little seed.

#### (iii) INVESTIGATION ON SEEDS.

(a) *Seed weighments and germination tests.*—During the year under report 162 weighments were made including 8 new species, and germination tests for 130 species were recorded. The data will be incorporated in the revised Forest Bulletin 41.

(b) *Effect of size of seed on germination and growth of seedlings.*—The experiment (No. 57) was repeated with *Terminalia chebula*. Seeds were graded into 4 diameter classes, from 0.5" to 0.9", and at the end of the 1st growing season, it was found that the bigger the seed the better the result as regards germination and height growth, thus confirming the previous year's conclusions.

(c) *Seed storage.*—Nine species were added for storage during the year.

After 3 years' storage in sealed tins seeds of *Acacia catechu* failed to germinate and those of *Bombax malabaricum* shewed only 1 per cent. germination as compared with 2 per cent. and 37 per cent. after 2 years.

Seeds of *Schleichera trijuga*, stored for 3 years in sealed tins and gunny bags, failed to germinate in either case having given 19 per cent. and 2 per cent. germination after 2 years. *Melia azedarach* seeds, stored for the same period in gunny bags also failed to germinate, but those kept in sealed tins shewed 68 per cent. germination after the same period of storage—practically the same figure as after 2 years.

Seeds of *Dalbergia latifolia*, *Chickrassia tabularis*, *Terminalia chebula* and *Acacia modesta*, stored in gunny bags for 2 years, shewed a germination per cent. of 0, 0, 0.7 and 4, whereas stored in sealed tins for the same period they shewed a germination per cent. of 0, 0, 0.3 and 15 respectively. *A. modesta* shewed 22 per cent. germination after a year's storage in gunny bags, and *Terminalia arjuna* shewed 49 per cent. germination after 2 years' storage in this way.

Seeds of *Acacia catechu* with an initial germination capacity of 56 per cent., stored in 1934 in a sealed tin, dropped to 14 per cent. germination after a year.

#### (iv) INVESTIGATION ON SEEDLINGS.

The morphological seedling studies as reproduced in Troup's Silviculture of Indian Trees were completed for the following 9 species :—

*Eugenia utilis*, *Pyrus pashia*, *Pterocarpus macrocarpus*, *Schima wallichii*, *Swintonia floribunda*, *Stephegyne diversifolia*, *Terminalia oliveri*, *Turpinia pomifera* and *Vateria indica*.

13 other species as mentioned below were partly studied :—

*Anisoptera glabra*, *Alseodaphne owdeni*, *Derris robusta*, *Diospyros tomentosa*, *Ficus glomerata*, *Lagerstroemia parviflora*, *Lophopetalum fimbriatum*, *Olax scandens*, *Olea cuspidata*, *Phoebe hainesiana*, *Sapium baccatum*, *Stereospermum xylocarpum* and *Vitex peduncularis*.

#### (v) INVESTIGATIONS ON TREES AND CROPS.

(a) *Seasonal course of height growth*.—The investigation was continued for 12 common Indian species.

(b) *Phenological data*.—Observations were continued on 13 species. Preliminary compilation was done last year, and it is hoped to issue a note on the subject before long. Collaboration of the Provincial Silviculturists has been successfully invited.

(c) *Inheritance of individual characters.*—The two experimental plots, planted up with seedlings raised from seeds of figured and unfigured parent trees of *Terminalia crenulata* are fully stocked and promising. Two more *Pinus longifolia* plots were added during the year for determining whether high resin yielding capacity is a hereditary character or not.

(d) *Inheritance of climatic race characters.*—The All India teak seed experiment dealing with 11 origins is still under observation but the majority of the plants were killed back by frost, and it appears that the long term plots will be difficult or impossible to maintain at Dehra Dun. Difference in appearance of the bark and the colour of foliage between the Burma and local origins of *Acacia catechu* still persists, as reported last year.

(e) *Inheritance of physiological race characters.*—The small plantations of *Butea* and *Schleichera* forms, reported to behave differently under lac culture, were again frosted but some of the trees are nearly big enough for the further stages of the investigation.

(f) *Soil quality class indicators.*—The quadrats in plantations of different important species in the Demonstration Area were continued and mapping done as usual.

(g) *Congestion in bamboo clumps.*—During the rains of 1935 two different treatments, namely topping and stripping of new culms, were applied to selected clumps in the Experimental garden to study their effects on congestion in the clumps of *Dendrocalamus strictus*. It is too early yet to draw any conclusions.

(h) *Root competition.*—The investigation in *sal* and *chir* was continued, and new experiments laid out with *Cedrela toona*, *Phoebe lanceolata* and *Holoptelea integrifolia*.

The 1932 experiment with *Cedrela toona* was closed after 2 seasons as trenching had no effect on the plants and iron-sheeting around the plants did more harm than good. There was no significant difference between trenching and control plants but a marked difference with iron-sheeting.

The 1933 experiment with teak (C. 19) was concluded on account of damage by frost. After 2 seasons the trenching at a distance of 8' from the plant gave the best results, and that at 4' the worst. There was practically no difference between the untrenched control and the trenching at a distance of 6'.

(i) *Thinnings in young plantations.*—5 sets of experiments in replicated series have been laid out in the young pine plantation in the Demonstration Area where the rapid rate of growth promises interesting results in a few years' time.

(j) *Pruning versus natural cleaning*.—The experiment laid out in *chir* last year is being maintained and a new set, mainly dealing with frost-caused forking, laid out in *sal*.

(k) *Twist in Pinus longifolia*.—The experiment of inducing twist in 1926 *chir* plantations is being continued. Trees felled last year have been examined for twist and results will be published in due course.

*Chir* plants raised from X-ray treated seeds are progressing.

#### (vi) ARTIFICIAL REGENERATION.

Weather conditions affecting the results obtained were as follows :—

The 1934 monsoon arrived early, on the 17th June, and rains were regular up to September. The following cold weather was marked by a fairly good rainfall, but a very severe frost occurred during January 1935 resulting in heavy casualties in teak, *sal*, rosewood, *sain* and other broad leaved species. In 1935, the monsoon appeared rather late, the first showers falling on the 2nd July. Rains, however, were more or less continuous up to the 21st September. A spell of dry weather followed thereafter and there was practically no rain up to the beginning of February 1936, when some of cold weather planting was done. The first frost occurred on the 15th December 1935. It was only severe for the first night or two. However last year's coppice shoots of teak, *sal*, *Terminalia tomentosa*, *Adina*, etc., were not hard enough to withstand this relatively light frost.

(a) *Line sowings*.—The following species were tried in shade as well as in the open in 1935 :—

*Holoptelea integrifolia*, *Lagerstroemia parviflora*, *Hymenodictyon excelsum*, *Schleichera trijuga*, *Terminalia arjuna*, *T. paniculata* and *Machilus gamblii*; of these *Schleichera*, *Machilus* and *T. paniculata* did not germinate, but others were quite successful. Plants were slightly frosted during the cold weather of 1935-36.

(b) *Rains entire planting in the open*.—The following species were tried in 1935. The survival percent. at the end of the year is given in brackets.

*Boswellia serrata* (8), *Diospyros tomentosa* (78), *Cedrela toona* (61), *Cordia myxa* (84) and *Terminalia paniculata* (56).

As regards the planting in 1934, the following are the survival percent. at the end of the 1st and 2nd growing seasons respectively :—

*Lagerstroemia flos-reginae* (99-15), *Terminalia arjuna* (79-60), *Cedrela toona* (75-0), *Mallotus philippinensis* (63-0), and *Pterospermum acerifolium* (97-0). The last three species mentioned

above died wholesale during the hot weather of 1935. The first 2 species were frosted during the following cold weather.

(c) *Rains entire planting in cleared lines.*—The following species were put out in 1935, the survival percent. at the end of the year being given in brackets.

For the species tried in 1934 the following results indicate the survival percent. at the end of the 1st and 2nd growing seasons respectively. *Cedrela toona* (69-25), *Lagerstroemia flos-reginae* (100-73), *Mallotus philippinensis* (83-66), *Pterospermum acerifolium* (91-81) and *Schima wallichii* (13-nil). For no assignable reason, the last mentioned species will not grow well under any conditions tried.

(d) *Winter entire planting in the open and cleared lines.*—The survival percentages for species put out in cleared lines during 1932-33 cold weather for the 1st, 2nd and 3rd seasons respectively were :—

*Mallotus philippinensis* (46, 43, 42), *Litsaea polyantha* (29, 19, 19) and *Lannea grandis* (76, 75, 76).

The species put out in the open as well as in cleared lines in January 1935 as mentioned in last year's report were all killed by frost shortly after they were planted.

(e) *Winter stump planting in the open and in cleared lines.*—The survival percentage of *Bauhinia variegata* and *B. retusa*, which were tried in cleared lines in January 1933, was 74,71 and 71, and 76,59 and 60 at the end of the 1st, 2nd and 3rd growing seasons respectively.

The following species were put out in January 1934 and their survival percentage at the end of the 1st and 2nd growing seasons is given against each species :—*Ougeinia dalbergioides* (24-22), *Stereospermum suaveolens* (89-92), *Celtis tetrandia* (51-23), *Cedrela toona* (38-25).

*Ougeinia dalbergioides* was also tried in cleared lines in January 1934 and the survival percentage at the end of the 1st and 2nd growing seasons was 21 and 16 respectively.

Of the 7 species put out in the open in January 1935, the following survived, the survival percentage at the end of the year is as shown :—*Acacia catechu* (3), *Acacia modesta* (4) and *Prosopis juliflora* (14). Other species were all killed by frost soon after planting.

The following species were planted in cleared lines in January 1935 and their survival percentage at the end of the year is given in brackets against each species :—

*Prosopis juliflora* (20), *Chickrassia tabularis* (14) *Acacia modesta* (7), *Pterospermum acerifolium* (8), *Acacia catechu*, *Litsaea polyantha*, *Chloroxylon swietenia* and *Trewia nudiflora* (nil).

(f) *Rains stump planting in the open.*—With species tried in 1934 the following results were obtained at the end of the second growing season, the figures in brackets giving the survival percent. at the end of the 1st and 2nd seasons respectively :—

*Olea glandulifera* (60-0), *Cassia siamea* (86-4), *Stereospermum suaveolens* (stumps 99-100) and *Chlorozylon swietenia* (83-51); *Mallotus philippinensis* (98-49) in one case and (76-nil) in another, *Terminalia chebula* (85-50) and *Prosopis juliflora* (79-57). Root sections of *Stereospermum* tried under the same conditions shewed 98 and 94 per cent. survival.

The species put out during the rains of 1935 are mentioned below with their survival percent. at the end of the year mentioned in brackets :—

*Lagerstroemia flos-reginae* (100), *Pongamia glabra* (100), *Terminalia chebula* (100), *Bauhinia purpurea* (96), *Juglans regia* (95), *Grevillea robusta* (92), *Prosopis spicigera* (90), *Boswellia serrata* (38), *Terminalia myriocarpa* (12) and *Terminalia arjuna* (4).

(g) *Rains stump planting in cleared lines.*—The two species put out in 1934 showed the following survival percent. at the end of the 1st and 2nd seasons respectively :—

*Mallotus philippinensis* (89-74), and *Phoebe hainesiana* (70-9).

The following species were tried in 1935, their survival percent. at the end of the season being given in brackets :—*Lagerstroemia flos-reginae* (100), *Pongamia glabra* (98), *Terminalia citrina* (74), *Bauhinia purpurea* (70), *Juglans regia* (45), *Grevillea robusta* (55), *Swietenia macrophylla* (44), *Prosopis spicigera* (36), *Terminalia myriocarpa* (6) and *Canarium bengalensis* (13).

(h) *Storage of stumps before planting.*—The 1934 experiment with teak stumps stored on a cement floor for 0, 4, 8, 13 and 20 days showed the following survival percent. at the end of the 2nd season : 78, 76, 62, 42 and 8 with corresponding average heights of 30·8", 30·2", 29·6", 23·7" and 21·0".

In 1935, *Acacia catechu* and *Eugenia jambolana* were tried under similar conditions.

*Acacia catechu.*—250 stumps of different diameters prepared on the 20th July 1935 were planted out in comparable sets of 50 stumps after storage up to 13 days in moist sacking under a thatch shelter. Rain was more or less continuous during the whole period of storage. At the end of the growing season the survival percent. was 60, 50, 42, 38

and 26 with corresponding average heights 12.2", 11.7", 10.8", 6.7" and 6.8" for stumps stored for 0, 4, 7, 10 and 13 days respectively.

*Eugenia jambolana*.—The number of stumps and the initial treatment were the same as for *A. catechu* above, except that the stumps were prepared on the 21st July 1935. At the end of the growing season the survival percent. was 92, 98, 98, 98 and 96 with corresponding average heights 3.5", 3.6", 3.6", 3.3" and 3.3" for stumps stored for 0, 4, 7, 10 and 13 days respectively. This indicates a hardiness even surpassing that of teak.

(i) *Early planting of stumps without irrigation*.—The fortnightly planting of teak stumps was started from 15th January 1935 in the open and from 31st January 1935 in cleared lines under shade, the last date of planting being 11th July 1935 for the former and the 26th July 1935 for the latter. The survival percent. after one growing season was nil upto the 9th set (mid January to mid May) and 4, 36, 100 and 100 with corresponding average heights 5.0", 5.8", 7.7" and 5.0" for the rest of the sets (end May to mid July) planted in the open. The survival percent. figures for the cleared lines in shade are 20, 12, 12, 12, 16, nil, nil, 12, 32, 60, 100, 100 and 92 with corresponding average heights 5.8", 5.0", 5.0", 5.7", 5.8", nil, nil, 5.7", 3.5", 5.3", 5.4", 4.1" and 2.9". The value of the shade is clearly brought out but the survivals are too few for practical purposes. It would appear from the above figures that teak stumps planted one week before the break of rains give the best result, the optimum period extending upto one week after the rains have set in.

(j) *Comparison of nursery stock and natural seedlings*.—The survival percent. of *Eugenia jambolana* originally grown in the nursery and planted out in 1932 has fallen from 90 to 60 in four growing seasons whilst that of natural seedlings planted out the same time varied from 93 to 43. There was no appreciable difference in heights between the two sets.

The experiment was repeated with *Eugenia jambolana* in 1935 and the survival percent. at the end of the 1st season was 96 both for forest and nursery grown seedlings, and there was no significant difference in their heights.

(k) *Comparison of nursery and forest stumps*.—The forest stump percent. of *Eugenia jambolana* put out in 1933 continues to indicate a superiority over nursery grown stumps, survivals now being 76 and 92 per cent. respectively.

*Bauhinia variegata* was tried in 1935 under this experiment and the survival percent. at the end of the year was 94 for nursery grown stumps and 86 for forest stumps, average heights being 8.1" and 8.0" respectively.

(1) *Comparison of sowings, transplants and stumps.*—The following tabular statement summarises the condition of different species put out from 1932 to date :—

Year.	Species.	Method (sowing or planting).	SURVIVAL PERCENT. AT THE END OF THE YEAR.				Average height at the end of 1935 (inches).	REMARKS.
			1932.	1933.	1934.	1935.		
1932	<i>Tectona grandis</i> . . .	Entires in pits . . .	70	37	37	32	78.3	
		Stump planting in standard pits.	98	98	98	95	109.3	
		Stump planting in crowbar holes.	93	92	92	87	109.8	
	<i>Bauhinia variegata</i> . .	Direct sowing . . .	100	100	98	98	111.3	
		Entire transplanting . .	95	87	87	87	84.8	
		Stump planting . . .	100	98	98	98	107.9	
	<i>Bombax malabaricum</i> . .	Direct sowing . . .	95	60	60	55	22.7	
		Entire transplanting . .	95	58	58	48	20.4	
		Stump planting . . .	95	88	88	88	38.0	
	<i>Acacia catechu</i> . . .	(Vide last year's report)	..	..	..	..	..	
1934	<i>Eugenia jambolana</i> . .	Direct sowing . . .	..	..	03	5	6.0	Was discontinued in June 1935 having attained an average height of 10'.
		Entire transplanting . .	..	..	60	..	..	
		Stump planting . . .	..	..	78	33	9.2	
	<i>Stereospermum suaveolens</i> .	Entires in crowbar-holes.	..	..	53	8	3.0	
		Entires in standard pits	..	..	60	13	1.6	
		Stump planting . . .	..	..	98	100	9.0	
1935	<i>Bombax malabaricum</i> . .	Direct sowing . . .	..	..	..	70	1.8	
		Entire transplanting . .	..	..	..	93	2.9	
		Stump planting . . .	..	..	..	90	2.8	
	<i>Acacia catechu</i> . . .	Direct sowing . . .	..	..	..	83	4.9	
		Entire transplanting . .	..	..	..	63	5.6	
		Stump planting . . .	..	..	..	78	7.1	
	<i>Pterospermum acerifolium</i> .	Direct sowing . . .	..	..	..	88	2.7	
		Entire transplanting . .	..	..	..	100	4.3	
		Stump planting . . .	..	..	..	65	2.3	
	<i>Cedrela toona</i> . . .	Entire transplanting . .	..	..	..	95	3.7	
		Stump planting . . .	..	..	..	100	7.5	

(m) *Araucaria plantations*.—The *Araucaria cunninghamii* plantation is promising and has attained a maximum height of 8'4" in 4 years.

The survivals in the small plantation of *A. bidwillii* have reached a maximum height of 10'3" in 6 years, and are doing well.

#### (vii) NURSERY WORK.

The seed crop on trees in the Dun valley was fairly good during the year. As usual, stock was raised for various species for use in the Experimental Garden and Demonstration Area.

The following experiments were carried out in the nursery during the year under report.

(a) *Experiments with different degrees of nursery bed shades* (Experiment 14) were done with *Adina cordifolia* and *Anthocephalus cadamba* and the following are the results at the close of the year:—

*Adina cordifolia*.—In the *tin shaded* sections of beds the development of plants was best due to more uniform germination. Plants at the edges of beds were getting more light than those inside and were very much better than the latter. Sections with *thatch shade* had numerically the best germination, but seedlings were slightly inferior in development to those under the tin shade.

There was excessive damage due to drip in the sections with *batten shade* and results were very poor.

In the *unshaded sections*, the seeds were washed together (by surface drainage) and germinated in clumps, but their development was very poor due to intense competition.

*Anthocephalus cadamba*.—The washing of seeds into heaps was much less than with *Adina*. In the *tin shaded sections*, stocking was poorer, less uniform and growth less than under *thatch shade* owing to much damping off. Effect of drip was, however, nowhere apparent. The *thatch shaded* sections were evenly stocked but development slightly less than under *batten shade*. The sections with the *batten shades* were best of all with fairly even stocking. The *unshaded sections* had practically no germination.

(b) *Seed pretreatment* (Experiment 13).—The experiment was repeated with *Terminalia chebula* in June 1935. 350 seeds of *T. chebula* were subjected to each of the following treatments:—(i) Control, (ii) soaked in cold water and (iii) soaked in slaked lime both for 48 hours before sowing.

The germination percent. at the end of the growing season was 31.7, 48.9 and 34.3 with corresponding average heights 3.9, 4.2 and 4.1 for the three treatments respectively.

(c) *The manuring experiment* (No. 16) in *nursery beds* was carried out with *Cedrela toona* during 1935. The beds selected had the same past history.

*Crotalaria juncea*, *Cassia tora* and lucerne were used as green manures in 3 different beds whereas farmyard (cowdung) and artificially prepared farmyard manures were added to 4 other beds separately at the rate of 10 and 20 baskets of each manure per bed. The 8th bed was left as a control.

The average height of the best plant per running foot was as follows for each kind of manure :—

	Inches.
Farmyard manure : 10 baskets . . . . .	4.3
Farmyard manure : 20 baskets . . . . .	2.8
Artificial farmyard manure : 10 baskets . . . . .	2.2
Artificial farmyard manure : 20 baskets . . . . .	2.5
<i>Crotalaria juncea</i> . . . . .	2.4
<i>Cassia tora</i> . . . . .	2.3
Lucerne . . . . .	2.8
The control bed had an average height . . . . .	2.1

(d) *Best time for seed collection* (Experiment No. 79).—*Terminalia chebula* seed was collected in 5 lots, each lot on a different date, i.e., on 19th December 1934, 3rd January 1935, 14th January 1935, 23rd January 1935 and 2nd February 1935. 250 seeds for each of the first three lots, 200 for the fourth and 100 for the fifth lot above were selected at random and sown in nursery bed in April 1935. The germination percent. was 28, 6.4, 5.6, 6.5 and 6.0 with corresponding average heights 4.7, 2.4, 2.0, 3.2 and 1.3 for first, second, third, fourth and fifth lots respectively at the end of the year.

#### (viii) MISCELLANEOUS.

No special new experimental work was taken up during the season. A manuscript by Mr. Deogun collecting all available information concerning the silviculture and management of the important bamboo *Dendrocalamus strictus* is still pending publication but is expected to be ready for the Press shortly.

#### (ix) RECLAMATION AND AFFORESTATION.

Teak and rosewood plantations having proved a failure, owing to frost and fungi, it has been decided to abandon them. Teak is being replaced by *khair*, bamboo, mulberry, *tun*, etc., in different blocks. 3 more compartments in the teak working circle were sown with *khair* in lines 9 feet apart in July, 1935, and although it was affected by frost

during the last cold weather, it is doing well now. The 1934 *khair* is growing well in 2 of the compartments having attained a height of about 8' in the 2nd year. Six more teak compartments, at present under *taungya* cultivation, will be ready for sowing of the above mentioned species in rains 1936.

An area of about 15 acres in the Rosewood Working circle has been leased out for *taungya* cultivation for a period up to the summer of 1937, when this area will be sown with *chir* pine in which a new spacing and thinning experiment is proposed to be carried out.

(a) *Sal working circle*.—Failed patches were again sown with *sal* seeds of Dehra Dun, Haldwani, Hoshiarpur, Kheri, and Gorakhpur origins. Frost again cut back many of the last year's tender coppice shoots.

(b) *Chir working circle*.—There being no *chir* seed available during the year 1935, casualties could not be replaced.

C-grade thinning was done in some of the 1925 and 1926 plantations, and a systematic pruning of selected dominant stems was carried out in 4 of the thinned compartments. One of the 1926 compartments was control-burnt in February, 1936, with the object of following the effects on increment and branchiness.

## II.—STATISTICAL SECTION.

### (i) YIELD TABLES.

The total number of sample plots maintained this year is 1,537 which shows an increase over last year's figure by 35 plots. Of these, Burma and the United Provinces contribute a greater portion having 331 and 361 plots respectively and the rest are shared by all other provinces including Kashmir State. The necessary computations were done for 323 out of 388 sample plot files received. A stand table for *Pinus longifolia* was prepared and sent to the press. Preliminary work has been begun for the compilation of yield tables for plantation teak for which 346 sample plots and 655 measurements are available.

### (ii) VOLUME TABLES.

A standard and commercial volume table for *Dalbergia sissoo* has been compiled and published as an Indian Forest Record. Stump analysis data on 99 stumps were computed for Madras; and calculation was also done for 518 trees for the standard volume and 608 trees for commercial volume for the Punjab.

## (iii) MISCELLANEOUS.

Investigations continue to be carried out to examine the possibility of photographic methods of measurement of standing sample trees. The extensible ladder was loaned to Madras for trials there.

Two parties were in the field this year. One party under the direct supervision of the Silviculturist measured 40 sample plots in the Lower and Upper Bashahr divisions. The other party with the Statistical Assistant in the Jaunsar division was engaged on the collection of sapwood data for deodar and analysed 280 felled trees. The data were worked up later and found to permit of tentative conclusions requiring check with further figures which will be collected in the coming season.

## III.—MISCELLANEOUS.

## (i) PHOTOGRAPHIC SECTION.

The routine work carried out compares with previous years as follows :—

Year.	Negatives made.	Prints made.	Lantern slides made.	Colour Photos.
1932-33 . . .	677	2,278	44	..
1933-34 . . .	1,095	2,271	400	..
1934-35 . . .	932	3,420	130	18
1935-36 . . .	748	2,791	301	6

Of the new negatives 75 were photographs taken in Bashahr, 23 in foreign countries and 8 in the Dehra Dun division all by the Silviculturist.

268 photographs were taken in the Timber Testing Section, and 161 more were taken for other different branches and sections of the Institute.

213 negatives were sent by Provincial Silviculturists of Madras, United Provinces and by the Research Officer, Bihar and Orissa, to be lodged in the Forest Research Institute collection.

The total number of prints in the general series comes to 3,529 and in the specific series 4,341, against 3,372 and 4,203 respectively for the last year.

930 prints were prepared for different Provinces and States, 93 photographs were used as illustration in various publications.

115 lantern slides were prepared for the Forest Research Officer, Bihar and Orissa, and 14 other slides for Silviculturist, U. P. The former for showing at an Industrial Exhibition at Patna and the latter for the purpose of local propaganda.

172 lantern slides were prepared and added to the collection.

The Range Officer of the Demonstration Area of the Institute was sent to Kotdwara with some 40 slides where he delivered a public lantern lecture on the utility of forests illustrated by slides from the collection of the Institute.

The collection of stereos was improved and a beginning made on a collection of cinema films with a copy of a film of forest work kindly loaned by Mr. D. Stewart.

#### (ü) RECORDS.

No progress can be reported on referencing of arrears of forest literature which have actually increased since last year. The situation will be somewhat relieved by the monthly list of references issued from the Imperial Forestry Institute, Oxford, from the beginning of 1936, but these will not obviate the necessity of dealing with the literature from the special Indian view point. Abstracts of Indian literature were prepared as usual for Biological Abstracts.

The compilation of a book on Indian Silviculture which will summarise the data collected on the General Ledger Files (by subjects) has been commenced and will be completed in 1936, whilst Part II dealing with the Silvicultural Systems has already been drafted by Mr. Trevor.

Forty-one new books were added to the library during the year including 25 Working Plans bringing the total up to 674 volumes and 483 bound periodicals. A list of additions with brief abstracts was circulated as usual.

#### (iii) WORKING PLANS.

Notes were written on the South Coorg and Melghat, C. P., draft working plans and the suggestions made have been generally adopted in the plans.

#### (iv) MUSEUM.

The large model demonstrating the influence of forest cover on preventing erosion has been completed and demonstrated to many distinguished visitors. Several readjustments especially of the rainfall arrangements have had to be made to ensure an even and realistic fall, but the model reflects much credit on the Museum Artist (B. Darshan

Singh). Work is being commenced on the ninth of the ten large wall cases, the subject being the influence of local climate on vegetation; the phenomena of altitudinal zonation, succession and retrogression, and the effects of site and soil will all be illustrated. The earlier models have been improved in several respects.

#### (v) STAFF AND TOURING.

The writer was on leave from 19th April till the end of the year, Mr. M. V. Laurie again officiating during his absence. Mr. J. N. Sen Gupta joined the Branch from Bengal in succession to Mr. P. N. Deogun as Experimental Assistant whilst Mr. Kakazai remained in charge of the Statistical Section. Ranger Hari Krishan Madhwal continued in charge of the Experimental Garden, etc.

The Silviculturist toured with a sample plot field party in Bashahr, Punjab, in May-June whilst the Statistical Assistant collected deodar sapwood data with another party in Chakrata, U. P. The Experimental Assistant made a long tour visiting evergreen forests in Madras, Coorg, Mysore and the Andamans.

#### (vi) VISITING FOREST OFFICERS.

As usual several officers visited the Branch to discuss their local silvicultural problems and research methods. Among them were Mr. Warren on taking over the post of Forest Research Officer, Bihar and Orissa, Mr. Mitchell, Chief Forest Officer, Coorg, and Mr. Holmes of the Ceylon Forest Service who is taking up the post of Silviculturist in Ceylon and for whom a tour in India was arranged.

## CHAPTER III.—BOTANY BRANCH.

1. *Systematic Botany*.—The study of the Indian species of *Terminalia* of the section *Pentaptera* has been completed and a draft report with illustrations prepared; this report is in the course of final preparation for publication. The systematic study of this group has been found to be difficult owing to the absence of well-defined characters for distinguishing the forms and species and some overlapping of characters, difficulties which have hitherto been the cause of difference of opinion in the status of the various groups.

A draft paper dealing with the following five species of forest importance belonging to the family *Dipterocarpaceae* has also been completed with illustrations; three allied species of *Shorea* from Assam and Burma, *S. assamica* Dyer, *S. floribunda* Kurz and *S. sericeiflora* Fisch. and Hutch., and two Burmese *Hopeas*, *H. oblongifolia* Dyer and *H. helferi* Brandis. A paper dealing with five species of this family, including the eleventh species of *Dipterocarpus* from Assam and Burma, i.e., *D. macrocarpus* Vesque, was published in the Indian Forest Records; material of the two remaining Indian species of *Dipterocarpus* occurring in South India, i.e., *D. indicus* Bedd. and *D. bourdillonii* Brandis was obtained and examined for the completion of the study of the Indian species of this genus. A note dealing with the systematic study of some Indian and Burmese *Dilleniaceae* was published in the *Indian Forester* and a paper on a new genus in the *Connaraceae* submitted for publication.

Two further papers, one on the Indian species of the genus *Psilotum* and another dealing with some recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain—the area covered by Duthie's flora—were published.

2. *Herbarium*.—During the year 2,636 specimens, received from various sources, were incorporated in the herbarium. About one thousand of these represent foreign (non-Indian) specimens obtained by exchange from various herbaria such as the herbarium of the Arnold Arboretum and the Gray Herbarium of the Harvard University, the herbaria of the New York Botanic Garden, the Oxford University and the Royal Botanic Garden, Calcutta. About 500 specimens were obtained from the collections made by the Forest Botanist and his staff, chiefly in Chittagong, Kumaon, Kulu and the Dehra Dun and Saharanpur districts; the remainder was from collections received from Forest Officers from various parts of India, the most notable of these being those of the Botanical Forest Officer, Shillong, 131 specimens; Mr. H. G. Champion, I.F.S., 122 Naini Tal and Pindari specimens; Mr. V. S. Rao, I.F.S., about 100 Chittagong and Northern Bengal specimens,

and Dr. N. L. Bor, I.F.S., 72 Assam specimens. Two small notable collections were received, one by Brigadier C. C. Foss from Maymyo (received through the Forest Botanist, Burma) and the other from Mr. R. Scott, Assistant Commissioner of the Nicobar islands. These incorporations do not include the large number of specimens still in hand which will not be incorporated till the determinations have been completed, such as an extensive collection received from Dr. N. L. Bor from the Khasia hills.

The following specimens were distributed from this herbarium either on an exchange basis or as donations :—

Arnold Arboretum, Harvard University, Jamaica Plain, Mass., U. S. A. . . . .	85
Gray Herbarium, Harvard University, Cambridge, Mass., U. S. A. . . . .	62
New York Botanic Garden . . . . .	100
Botanic Garden and Museum, Berlin . . . . .	198
Royal Botanic Gardens, Edinburgh . . . . .	64
Naturhistoriska Riksmuseet, Botaniska Avdelningen, Sweden . . . . .	78
Smithsonian Institution, United States Department of Agriculture, Washington . . . . .	46
Maymyo herbarium, Burma . . . . .	56
TOTAL . . . . .	689

The herbarium was visited by Professor Tyozaburo Tanaka of the Taihoku Imperial University for the examination of our herbarium collection of Rutaceae-Aurantioideae in connection with his monographic study of this group.

The herbarium material of *Avicennia* (117 sheets) sent out on loan from this herbarium to Dr. H. N. Moldenke of the New York Botanic Garden has been returned with the annotations of that author and this has considerably increased the value and usefulness of this material. The *Ixora* and *Pavetta* collections of this herbarium have been sent out on loan to Prof. C. E. B. Bremekamp of the University of Utrecht for study. The re-arrangement of the foreign (non-Indian) collections was continued and has progressed as far as the *Polygonaceae*; as in previous years this work has been done by the Herbarium Clerk in addition to his usual routine duties.

3. *Library*.—Thirty-eight volumes as well as the usual periodicals were added to the library during the year. The work of card-indexing references to special subjects in botanical literature was continued but could not be brought up to date for all the periodicals listed for want of time. A manuscript catalogue of the books in the Botanical Branch library was prepared; this has been drawn up into two parts, the first arranged according to a subject index and the second arranged alphabetically according to authors names.

4. *Identification of specimens.*—Owing to the increased attention that is now being given to the study of the soil flora and the determination of plants for the purpose of the preparation of local lists, the Forest Botanist and his assistant are now being called upon to identify an increasingly large number of plant specimens every year sent in by the Silviculturists, Working Plans Officers and others. This number has increased during the last decade from 649 determined in 1925-26 to 817 in 1930-31 and 1629 during the year under report. This work, which takes up a large part of the time of the small botanical staff dealing with Systematic botany, is done in the nature of routine work but is now increasing sufficiently to keep a whole-time systematic botanist well employed. Among the most notable collections that have been examined for determination are those of the Silviculturist of the Forest Research Institute, the Silviculturist, United Provinces, the Divisional Forest Officer, Silvicultural Research Forest Division, Lahore, Punjab, the Divisional Forest Officer, Chittagong Hill Tracts, Dr. N. L. Bor's specimens from Assam, Mr. V. S. Rao's Chittagong and Northern Bengal specimens, and the collections made by the Forest Botanist and his staff. Some of these collections are made in duplicate, triplicate or quadruplicate sets, one of which is retained for the Forest Research Institute Herbarium and the other correspondingly named and numbered sets distributed to various herbaria in exchange for other collections.

Sixty-four specimens were identified at the Royal Botanic Gardens, Kew, and sixteen at the Herbarium of the Royal Botanic Garden, Calcutta, for this herbarium.

*Tours.*—The Forest Botanist toured for about four weeks during the month of June 1935 in the East Almora division. Herbarium collections, ranging between the altitudes of 4,000 and 13,000 feet, were made for the Dehra Dun herbarium and for exchange with other herbaria. The Forest Botanist was unable to make any winter tour owing to lack of funds.

The Mycologist visited the Agricultural Research Institute at Pusa during the month of April, 1935, in connection with the determination of some fungus specimens collected by him during the previous year in the Chakrata forest division. He toured in the Chakrata division during the months of May to July, 1935, and conducted inoculation experiments in connection with the study of the life history of some *Peridermiums* on coniferous hosts. Inoculations of the roots of *Pinus excelsa* and *Cedrus deodara* with *Fomes annosus* and *Armillaria* sp. were also made to study their pathogenic behaviour on these hosts and *Trametes pini* was also used to inoculate them to study the parasitic nature of that fungus. A second tour was made in the same area in order to collect the results of the inoculation experiments done during

May to July and to make further inoculations with the teleutostages of rusts.

5. *Supply of Seed*.—Enquiries for authentic samples or quantities of seed are received from various scientific departments, institutions and individuals from various countries and these are supplied either on an exchange basis or on payment to approved indentors. Sixteen of these were in the nature of larger indents aggregating about 460 lbs. supplied chiefly to Indian, Colonial and Foreign Forest Departments. These indents were chiefly for *Pinus longifolia* for South Africa and Rhodesia, *Pinus khasya* for South Africa, *Terminalia belerica* for the Kutch State, *Leucaena glauca* for Bengal and the Punjab and teak and *Acacia arabica* for Java. Only a small portion of the quantity of seed of *Pinus longifolia* asked for by the South African Forest Department could be supplied owing to the poor seeding of that species during the year. The list of seeds offered in exchange from the Arboretum and Botanic Garden of the Forest Research Institute was revised and reprinted during the year and distributed generally to the Forest Department in India as well as to the various institutions with which seed exchange relations are maintained.

6. *Arboretum, Fruticetum and Botanic Garden*.—In the Arboretum 70 trees, representing 9 families and 15 genera, were planted out during the year as well as two new avenues, one with *Grevillea robusta* and the other with *Enterolobium timbouva*, two quick-growing species known to do well in the Doon. For the improvement of the grounds two hitherto untended plots of about an acre in area were fenced in and planted up with ornamental species also known to do well locally.

The plots in the Arboretum south of Hart road, hitherto planted up with trees belonging to the families Malvaceae, Sterculiaceae, Tiliaceae, Rhamnaceae and Anacardiaceae, were taken over by the Silviculturist. The replacing of many of these species has already been done in the plots around the Forest Economist's workshops and elsewhere where better results are expected on account of more suitable soil conditions and the easier watering arrangements during the hot weather. Some bamboos that had also been planted out in the abandoned plots have already been replanted elsewhere.

Growth has been generally good in the Arboretum and most plants have progressed favourably though some species received some set back during the year. The new Gold Mohur avenue was threatened with defoliation during the month of July by several species of *Chrysomelidae* and a species of *Rutelidae*; this attack was, however, successfully overcome by spraying with an insecticide and the plants are now progressing favourably. The avenue of *Phoenix canariensis* south of the Timber Testing offices was completely destroyed by the larvae of a large

*Curculionid* which attacked the leaf-bases of the plant. It has been necessary to completely replant this avenue with another species. Little or no damage was done by frost as the winter was a comparatively mild one.

Work in the Botanic Garden continues to make good progress and the results obtained already justify the abandonment of the old Fruticetum and establishment of the new garden. About 200 plants belonging to 32 families and 68 genera were planted out during the year. A small lily garden has been established and the success achieved with the rainy season and winter annuals has added greatly to the attractiveness of the garden which is now being visited by an increasing number of visitors. In the nursery and experimental garden about 600 plants were raised for planting out in the Arboretum, the Botanic Garden and in the avenues; in addition to this number about 450 plants were distributed for planting in the residential grounds at New Forest, in the adjoining Indian Military Academy and elsewhere. Several new foreign species were raised from seed obtained from various botanical institutions.

A list of plants (excluding annuals) grown in the grounds of the Forest Research Institute was drawn up and printed during the year. This list has been distributed to various botanical institutions and to the Provincial forest departments and is proving both an interesting and useful record. The preparation of this list took more time than was at first anticipated as it was not merely drawn up from existing records but involved a check of all the plants in the field during which notes regarding the condition of growth at New Forest of all the species were recorded.

The following plants were recorded to have flowered during the year for the first time at New Forest :—*Prunus capuli* Cav., *Millettia pachycarpa* Bth., *Acacia karroo* Hayne, *Gymnocladus canadensis* Lamk., *Feijoa sellowiana* Berg., *Cryptocarya amygdalina* Nees., *Alpinia bracteata* Roxb., *Piptadenia oudhensis* Brandis, *Lonchocarpus neuroscapha* Bth., *Bauhinia hookeri* F. Muell., *Moringa aptera* Gaertn., *Chrysanthemum cinerariaefolium* Vis., *Adenanthera microsperma* Teijsm. and Binn., *Cordia tremula* Griseb., *Acacia ferruginea* DC., *Acacia lenticularis* Ham., *Hibiscus costatus* Rich., *Hibiscus coccineus* Walt., *Koeleruteria paniculata* Laxm., *Aristolochia oblongata* Jacq., *Homalium tomentosum* Bth., *Eri-nocarpus nimmoanus* Mast., *Sechium edule* Swartz., *Nauclea sessilifolia* Roxb., *Aesculus punduana* Wall. and *Podocarpus gracilior* Pilger.

7. *Miscellaneous*.—Many enquiries of a technical nature received from forest officers and others from various parts of India were answered and advice given on botanical matters.

8. *Staff*.—The post of Forest Botanist was held throughout the year by Mr. C. E. Parkinson who was assisted by Mr. Mukat Behari Raizada, Lower Grade Assistant.

The mycological work reported on below was carried out by Dr. K. D. Bagchee, Mycologist, Mr. A. Hafiz Khan, Upper Grade Assistant, and Mr. R. N. Chatterjee, Laboratory Assistant.

### MYCOLOGY.

9. *Shisham root disease*.—The draft report on the work done during the last ten years in connection with the shisham root disease due to various pathogenes, of which a species of *Fusarium* plays an important part, has been completed.

10. *The die-back disease of Gmelina arborea*.—This problem is receiving the attention of the Mycologist and the Entomologist. Of the three insect pests observed on the *Gmelina* plants in the demonstration area at New Forest, i.e., *Tingid* bugs, *Alcides gmelinae* and *Culopepla leayana*, only the *Tingid* bug was investigated by the Entomologist for the study of its effect on healthy *Gmelina* plants. Inoculation experiments with these bugs did not give any conclusive results as to the extent of damage the insect is capable of doing. The part played by the other insects in this die-back disease is being investigated by the Entomologist.

Cultures of fungus, *Coniothecium* sp. isolated from the diseased twigs of *Gmelina* in the Silviculturist's experimental area at New Forest, were used to inoculate healthy and *Tingid* bug infected plants of *Gmelina* but with no useful results. Cultural work on the *Coniothecium* sp. was continued.

### 11. *Peridermium* spp. in India.

(i) *Peridermium himalayense* on the stem of *Pinus longifolia* and *Cronartium himalayense* on *Swertia* sp.—The work in connection with the investigation of these rusts has been completed and the biological relationship between these two rusts has been established by proper inoculations. Control measures for this rust (*Peridermium himalayense*) have been suggested. A paper on the results of pine inoculations with *Cronartium himalayense* (teleutostage) is being prepared.

(ii) *Peridermium indicum* on *Pinus excelsa* and *Cronartium* sp. on *Ribes rubrum*.—The leaves of *Ribes rubrum* were again successfully inoculated at Chakrata with cultures of *P. indicum*, and the uredo and *Cronartium* stages were reproduced on the leaves of *Ribes*. The specimens of *P. indicum* were procured from Tonnamarg, Kashmir, for the purposes of this inoculation. The results of these inoculation experiments corroborate those of previous year's, where *Ribes* plants were

successfully inoculated in three different localities in the Chakrata division during May and June 1934 with *P. indicum* received from the Kulu division.

Plants of *Pinus excelsa* inoculated with the *Cronartium* (teleuto) stage from *Ribes rubrum* at Chakrata in 1934 are showing symptoms of infection. A paper on this work is being drawn up.

(iii) *Peridermium orientale* (*P. complanatum*) on the needles of *Pinus longifolia*.—The leaves of *Campanula colorata* were successfully inoculated with the *Peridermium* from the needles of *Pinus longifolia* at Chakrata and the uredo and coleosporium stages obtained on the leaves of *Campanula colorata*. Needles of *Pinus longifolia* were inoculated with *Coleosporium campanulae* (teleuto stage) from *Campanula canescens* and the results are awaited.

(iv) *Peridermium cedri* on *Cedrus deodara*.—A series of inoculation experiments were conducted at Chakrata on eight likely broad-leaved alternate hosts with a view to determine the alternate host for the fungus. The broad-leaved species selected for this experiment are found to bear unrecorded species of *Coleosporium*, *Phakopsora* and *Pucciniastrum*, in nature. The leaves of deodar were inoculated with *Chrysomyxa deformans* (teleuto stage) on *Picea morinda* at Chakrata. As a result of this inoculation only pale spots were produced on the needles instead of the characteristic peridermium pustules.

(v) *Peridermium brevius* on *Pinus excelsa* needles.—This rust was correlated to a new species of *Coleosporium* on *Senecio rufinervis* and this was verified by a large number of successful inoculations of *Senecio rufinervis* with the spores of *Peridermium brevius* at Chakrata. Inoculations of *Pinus excelsa* with the *Coleosporium* (teleuto) stage on *Senecio rufinervis* have also been done and results are awaited.

(vi) *Peridermium thomsoni* on *Picea morinda*.—A search for this rust was made in the Chakrata division but with no success.

(vii) *Peridermium piceae* on *Picea morinda*.—This rust was reproduced by inoculating the needles of *Picea morinda* at Chakrata with *Chrysomyxa himalensis* (telcutostage) from *Rhododendron arboreum*. Inoculations of *Rhododendron arboreum* with the peridermium spores from *Peridermium piceae* have also been done and the results are awaited.

(viii) *Peridermium ephedrae* on *Ephedra vulgaris*.—Inoculations were made on *Ephedra vulgaris* with a *Hyalopsora* sp. on a *Polypodium* (fern), the only rust in the vicinity of the infected *Ephedrae* at Chakrata. The results are awaited.

(ix) *Peridermium* sp. nov. on *Abies pindrow*.—Cultures of this rust were procured from Pulga in the Parbatti range of the Kulu division;

these were successfully transferred to a fern (*Polypodiaceae*) on which the uredo and teleutostages were produced.

12. *Damping-off of forest tree seedlings in the nursery.*—It was not found possible to do any work in this connection for want of time.

13. *Cultural studies of wood-rotting fungi and their pathogenecity.*—Cultural studies and observations in connection with the wood-rotting properties of the following fungi were continued:—*Ganoderma lucidum*, *Polyporus gilvus*, *Polystictus versicolor*, *Polystictus sanguineus*, *Schizophyllum commune* and *Fomes annosus*.

Inoculations of young shisham plants in pots with pure cultures of *G. lucidum* and *P. gilvus* were repeated. Inoculations of *Pinus excelsa* and *Cedrus deodara* with *Armillaria* sp. were also repeated and *Trametes pini* was introduced for the study of its parasitic behaviour on the two coniferous species above mentioned. Inoculations of *Cedrus deodara* and *Pinus excelsa* with *Fomes annosus* have proved successful.

14. *Sal root disease including Polyporus shoreae, Fomes tricolor and Fomes fastuosus.*—Examinations of the various kinds of rot on *sal* were continued in the laboratory. A large number of sporophores collected from the diseased *sal* trees in Bihar and Orissa were identified. Cultures of *P. shoreae* and *F. tricolor* have been isolated and their cultural characters are being studied.

15. *Routine work.*—(i) The study of diseased *champ* specimens from Kurseong, Bengal, which included the cultural study of the organisms isolated from them and inoculation of healthy *champ* seedlings with these organisms has been completed and the report on the investigation has been submitted.

(ii) Investigations on the canker disease of *Dalbergia latifolia* in New Forest is being continued; the fungus organism associated with canker formations has been isolated and *D. latifolia* plants in pots were inoculated with the pure culture of the organism but with negative results.

(iii) The systematic study of various forest rusts from the Himalayas, which includes the collections from Kagan, Kulu, Chakrata and Kumaon, was continued as time permitted. The collections contain a large number of unrecorded species, some of which are heteroecious, some interesting fern rusts and a large number of others parasitic on the herbaceous hosts in the forests.

(iv) The collection of specimens of macro-fungi of the Himalayas including *Polyporaceae* and *Agaricaceae* has been gradually named at Kew and elsewhere and are being incorporated in the herbarium.

(v) Types of wood rot including those on living trees and timbers of forest importance are being gradually collected, identified, and prepared as museum specimens.

## CHAPTER IV.—FOREST ENTOMOLOGY.

Charge of the Branch of Forest Entomology was held by Dr. C. F. C. Beeson throughout the year.

Mr. J. C. M. Gardner was in charge of the section of Systematic Entomology until 16th May 1935 when he proceeded on leave and took over charge of his section from Dr. C. F. C. Beeson on his return from leave on 25th October 1935.

### *Insects of Teak.*

*Defoliators.*—Special attention was given to the study of parasites of the various teak defoliators based on material from United Provinces, Bengal and Orissa. Numerous experiments were performed and the parasites bred are being classified, many of them being new species. It has been proved that many of the important parasites can attack more than one species of defoliator. Periodical measurements of sample trees to correlate loss of increment and defoliation are being continued by the divisional staff at Nilambur, Madras.

### *Insects of Sandal.*

Reports on the seasonal incidence and distribution of the following groups have been prepared for the press: Lepidoptera, Coccidae, Cixiidae, Coreidae, Berytidae and Chrysomelidae. In this work over 12,000 specimens from the sandal sample plots were identified. These reports add 362 species to the insect fauna of sandal.

### *Insects of Champ.*

In North Bengal an area of about 843 acres, divided into 155 plantations, is covered by pure champ. Of these about one-third have been heavily attacked by the champ bug (*Urostylis punctigera*). The bug is indigenous in these forests and is known to feed on several other species of the Magnoliaceae besides champ (*Michelia champaca*). It is probable that the whole of the plantations will be subject to attack in the future. However a simple method of control by spraying which will check an attack in its early stages has been devised.

### *Insects of Casuarina.*

A preliminary survey of the insect fauna of *Casuarina equisetifolia* was made in the Balukhand plantation, Puri, Orissa. Of numerous species of insects found to attack *Casuarina* the following appear to be the most important: (1) Bagworms (*Clania* sp.), with two life-cycles

in the year attacking both young and old trees. Several species of parasites have been reared. (2) *Zeuzera coffeae*, whose larvae tunnel in and girdle young stems. (3) Coccidae (*Lecanium longulum* and on unidentified species) have been reported as causing considerable damage to young plants. Parasites of both species have been reared.

*Arbela tetraonis* was common in the plantation but as its attack appears to be limited to mature trees without causing much damage this species is of no great importance.

### *Insects of Plywood Factories and Sawmills.*

As a result of requests for assistance in controlling insect damage, three plywood and packing case factories in Assam were visited in December 1935 and January 1936.

The plywood factory and sawmills at Margherita, engaged in the manufacture of tea-chests of *Dipterocarpus pilosus* (hollong), were found to be hygienically controlled. The sources of infestation by *Lyctus* and *Heterobostrychus* were traced and found to be (a) in planks, scantlings, etc., stored for seasoning in the adjoining sawmill godown and in certain softwoods and the sapwood of hardwoods of various species, (b) in packing cases of *Bombax malabaricum* (semul) and of softwoods imported from Calcutta. These were infested with *Heterobostrychus aequalis*. As remedial measures it was suggested that the softwoods and pieces containing softwood be disposed of as early as possible and the remaining stock inspected at intervals, the attacked pieces to be burned or put in the drying kilns and to insist that sound packing cases from Calcutta should be supplied to the mills. With regard to panels of *Dipterocarpus pilosus* (hollong) it was suggested that they should be classified into "heartwood" and "softwood" and that the panels should be made up (a) entirely of heartwood and (b) entirely of veneers classed as softwood. Whereas the heartwood panels would not be attacked it was prescribed that the stacked sapwood panels should be brushed on all four edges with an aqueous solution of *Sodium silicate* (water glass) to plug up the pores thereby preventing beetles from laying eggs therein. Battens were to be treated with zinc chloride solution by immersing them in a hot 6 per cent. solution for 2 hours and then in a similar cold solution for the same time.

At Murkeong Sellek (Sadiya division, Assam), the plywood tea chest factory showed little evidence of damage by mill pests; *Heterobostrychus* and *Lyctus* were found in some of the old hollong hollock panels and hollong semul plywood boards. Protection against pin hole borers can be obtained by immersion of felled *Terminalia myriocarpa* (bollock) logs in the river at the earliest opportunity after felling. *Bombax malabaricum* (semul) logs are well protected by keeping the

bark alive. The longer semul is kept in water before sawing up, the less likely are the shooks to be attacked.

The Assam Match Co.'s factory at Dhubri was examined in the last week of December 1935. It was found that the *Bombax malabaricum* (semul) shooks for cases were liable to damage by *Heterobostrychus aequalis* which at times meant rejection of 10 per cent. to 25 per cent. of old stock. The cheapest remedy indicated was the destruction or disposal of all the old infested shooks on hand and periodical examination (either once in cold weather or twice in October and March), in future, of stacks of shooks, removing those showing an ejection of fine powdery dust. For future protection the company was advised to adopt treatment with zinc chloride.

#### *Damage to Pith Helmets.*

The Chief Ordnance officer, Cawnpore, sent specimens of insect attacked pith helmets purchased (under contract) for Army requirements. They were found heavily infested with *Rhizopertha dominica*. The attack had taken place at the time the hats were being shaped and dried before the addition of the layer of varnished gauze and paper. Experiments are in progress to investigate the possibility of using Ascu to control attack.

#### *General Insectary Work.*

During the year 150 consignments of attacked material were received from various forest divisions for examination. In the Insectary 543 cages were used. The total emergence of insects was 18,000 the majority of which were set and identified.

Life-history studies were carried out on lepidopterous defoliators of *Gmelina arborea*, *Lantana*, *Dalbergia sissoo* and numerous other species. The life-history of *Tingis besoni* and its association with dying back of *Gmelina arborea* were studied.

#### *Systematic Entomology.*

The reference collection now contains 15,800 different species of insects, 500 having been added in the year. As in previous years specialists in other parts of the world have assisted very considerably in classifying several families. There are however several lacunae, for example the parasitic hymenoptera, where the number of specialists is quite inadequate to deal with requirements. It is hoped that the Imperial Institute of Entomology may be able to appoint additional systematists to undertake the necessary studies in the near future.

The Systematic Entomologist has made steady progress in the pioneer field of the classification of coleopterous larvae and has pub-

lished several papers on the subject. He has also prepared descriptions of numerous new species of Coleoptera for publication.

*Tours.*—By Dr. C. F. C. Beeson to Naini Tal in April-May; to Kurseong divisions Bengal in July; to Delbi in October, to Dhubri, Kochugaon division, Dibrugarh, Murkong Selek, Pasighat (Sadiya division), Margherita and Lakhimpur division and to Puri (Bihar and Orissa) in December-January 1936; to Ranchi (Lac Cess Committee) in March 1936.

Mr. N. C. Chatterjee to Kurseong and Jalpaiguri divisions Bengal in June-July.

Pt. S. N. Chatterjee to Naini Tal in April-May; to Kurseong Bengal in July. Lala Buta Mal Bhatia to Dhubri and Kochugaon Dibrugarh, Murkong Selek, Pasighat (Sadiya division), Margherita and Lakhimpur division, and to Puri (Bihar and Orissa) in December to January 1936

*Museums.*—During the year 162 specimens showing damage done by insect pests were added to the entomological museum.

*Library.*—283 books besides periodicals were added to the Zoological Library during the year.

## CHAPTER V.—ECONOMIC BRANCH.

## Wood Technology Section.

## 1. RESEARCH.

(a) Work in connection with the preparation of macroscopic keys supplemented with X 10 photomicrographs for the identification of the more important commercial timbers of Assam and Bengal was continued, but progress was much hampered due to the paucity of authentic wood specimens of representative character. Now with the co-operation of various forest officers in these two provinces, wood blocks from different localities (supported by herbarium material) are being received and it is hoped that before long the work will be well in hand.

(b) Studies on the formation of the growth rings of the woods of *Acacia catechu*, *Bombax malabaricum*, *Eugenia jambolana*, *Pinus longifolia*, *Shorea robusta*, *Tectona grandis*, and *Terminalia tomentosa* were continued. Interesting results have been obtained regarding the growth activities of tropical trees and the consequent formation of growth rings in wood and these will be published shortly.

Further research on the distribution of parenchyma cells in the wood of *Terminalia tomentosa* were completed during the year and a detailed paper on the subject was sent to the *New Phytologist* for publication. The occurrence of parenchyma cells in the early wood of a diffuse-porous timber is recorded for the first time, and it is proposed to call these cells "initial," indicating their position in the growth ring. Previously they have been called "terminal" which indicated that they were supposed to be formed at the end of a growth ring. In view of these and other discrepancies in terminology, various types of parenchyma distribution found in Indian woods have been discussed in detail in the article and certain suggestions have been made regarding the restricted use of certain terms to standardise the anatomical description of woods.

(c) Work on the anatomical study of the woods of Indian *Dipterocarps* was continued. Some more specimens were received during the year from several provinces and these have been sectioned and mounted. Some foreign *Dipterocarps* were also received from various sources and these have also been cut, stained and mounted. The macroscopical and microscopical examination of the wood blocks and slides is progressing.

(d) The study of the different varieties of *Terminalia tomentosa* was continued during the year. It has been found that figured wood is not confined to any particular variety of laurel. The presence of figure in different varieties is erratic. Even in the same log figure may be

found in a few growth rings and may be entirely absent in the rest. This investigation is not yet complete. In order to make a comprehensive anatomical study, more varieties of *Terminalia* species have been cut and anatomical notes are being taken.

(e) The preliminary study on the relationship between the anatomical structure and physical properties of *Tectona grandis* was completed last year. As the Burma Forest Department is anxious to continue this work further, suggestions have been made for the proper selection of samples from as many different trees as possible. The work will again be taken up as soon as the new material comes to hand.

(f) The study of the woods of the Indian *Meliaceae* (mahogany family) was continued. Up to date 90 wood specimens from the collection of the Forest Research Institute have been cut and mounted. More specimens will be cut and studied during the current year.

## 2. IDENTIFICATION OF WOODS.

A very large number of identifications were carried out in response to enquiries from various sources. These included a wide range of materials, including solid timbers, veneers, plywood, match splints, fibres, fossil woods and charcoal.

The identification of the fossil wood from Assam that was started last year, has been finally completed, and a paper on it was sent to the *Annals of Botany* for publication. In this a detailed anatomical description is given and geological notes have also been included which show its affinity to the genus *Gluta*. Critical comments have also been included in the paper regarding the similarity and dissimilarity of this fossil wood with some of the other fossil woods so far reported on from India and other countries.

A large number of other fossil woods were received during the year and some work on some of them has been started but much time cannot be spared for this kind of investigation.

The total number of timbers identified during the year was about 300.

## 3. EXAMINATION FOR FUNGUS.

Numerous enquirers sent samples of wood suspected of having been attacked by fungus and asked for advice regarding the use of such timbers. Some of the most interesting cases are noted below :—

(a) Samples of Sitka spruce were sent for examination. It was proposed to replace some broken parts of an aeroplane with this wood. It was however found that the samples were badly attacked by fungus. This is a typical example of

how the Wood Technology Section can give valuable help to aircraft authorities. Such expert advice may make all the difference between safety and danger to human lives.

- (b) To settle a dispute about a contract for deodar (*Cedrus deodara*) for the Railway Board, samples were sent in for examination concerning certain discoloured portions in the wood. Under microscopical examination all the planks showed different stages of deterioration and in some cases the woody tissues were completely destroyed by fungus. A report to the effect that it was not safe to use the planks for any purpose where strength was required was sent out.
- (c) Hollock timber (*Terminalia myriocarpa*) from Assam having a curious dark colour in the wood which was responsible for a good deal of waste in conversion was sent in for examination. All the specimens were found to be attacked by fungus. The dark coloured wood in the centre of the trees was possibly the result of the abnormal conditions met with in the early life of the trees.

The number of wood specimens examined in this connection was 77.

#### 4. SPECIAL ENQUIRIES.

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for many business firms. The following are a few of the more important items :—

- (a) The histological study of a dead *Michelia champaca* (champ) plant where death was caused by an infestation of *Urostylis punctigera* insects, which are said to be responsible for the death of many champ trees in Kalimpong plantations, was taken up. In this connection a control healthy plant and an infected plant grown in Dehra Dun were also examined for comparative study. Sections from the original infected plant from Kalimpong, Bengal, showed the formation of cavities as the result of the disintegration of cells and these were always arranged in a concentric row in the wood. Similarly the plant from Dehra Dun, which died after being infected with insects from the Bengal trees, when sectioned showed the same type of cavities in the wood. Moreover it appeared that the formation of these cavities started in the lower part of the stem and went on increasing in size higher up the stem. Fungal hyphae

were abundant all over the stem from the bottom to the top but severity of attack was more at the bottom than in the top portion of the plant.

- (b) An examination of sal (*Shorea robusta*) discs from Ramnagar forest division which contained an unusual proportion of sapwood was made. Usually sal trees of 20" diameter and upwards have about one inch of sapwood but in this case the sapwood was from three to four inches thick, most probably due to particularly heavy fellings in the past in the area from which the trees came. It was found that the entire white portion was actually sapwood but from an anatomical point of view this sapwood was not much inferior to the heartwood, and if further thinnings are postponed the present sapwood will become converted into heartwood fairly rapidly and it will then be of the same quality as the present heartwood.

In this enquiry more than 140 specimens were examined.

## 5. INDEXING PERMANENT SLIDES, ANATOMICAL DATA AND PHOTOMICROGRAPHS.

In the course of routine work about 1,600 permanent slides were added to the authentic slide collection and these included a large number of species (both Indian and foreign) not previously represented. Whenever possible anatomical data have been taken from these slides and filed for future reference. 128 negatives and 694 photomicrographs were also taken during the year for publication and record.

## 6. COLLECTION OF AUTHENTIC WOOD SPECIMENS.

(a) *From India*.—A large number of authentic wood specimens from different provinces were received for the standard collection.

(b) *From abroad*.—During the year altogether 132 wood specimens were added to the foreign wood collection. These were received from Zurich (Switzerland), Ceylon, Uganda, Kenya and Japan. To the donors our sincere thanks are due for helping the Forest Research Institute to make its collection of the commercial timbers of the world as complete as possible.

## 7. DISTRIBUTION OF WOOD SPECIMENS.

In response to requests from abroad and various parts of India, 855 samples of timber were sent out to interested enquirers.

### 8. GENERAL.

A short course in Wood Technology was given to the following officer :—Mr. B. S. Sindhn, Assistant Works Manager, North Western Railway.

12 lantern slides of important Madras timbers were supplied to the Principal, Madras Forest College, for instructional purposes, and as usual a number of photomicrographs were sent to various persons interested in wood identification.

### Timber Testing Section.

#### SPECIAL INVESTIGATION.

(a) The study of the influence of friction on the results obtained with the standard shearing test tool was continued. Sufficient data have now been accumulated. The analysis of results will be taken in hand as soon as possible.

(b) Tests on teak solebars sent by the Utilization Circle, Rangoon, were made in order to determine the quality of the wood. It had been found that teak solebars often failed when accidents occurred and this had prejudiced the Railways against their use. The specimens sent were found to be extremely slow-grown and porous. A report on the tests was sent to the Forest Economist, Utilization Circle, Ahlone, Rangoon.

(c) The preliminary tests on *Fraxinus micrantha* from Naini Tal Division, U. P., were completed. This species was found to be superior to both English ash and American white ash. It seems to be a promising species but at present it is not available in sufficient quantities to exploit for sports requisites.

(d) Some preliminary tests were made to determine the comparative strengths of sapwood and heartwood of sal from Ramnagar Division, U. P. It was noticed that sal trees in that division produced an abnormal width of sapwood which was a great disadvantage as it had to be removed when the logs were converted into sleepers. In some cases as much as 3" to 4" of sapwood was found. The results of the preliminary tests are not strictly conclusive owing to the small amount of material tested. A further investigation of this matter appears to be necessary.

(e) Special tests were made on billets of naturally and artificially grown pyinkado (*Xylia dolabriformis*) from Bhamo Division, Burma, in order to compare their strengths. No difference of any practical importance was found although the artificially grown timber was a little bit stronger. A report was made to the Forest Economist, Utilization Circle, Ahlone, Rangoon.

(f) Tests were continued in conjunction with the Seasoning Section to find out the effect on strength of different treatments given to wood before seasoning. The species dealt with were *Hopea parviflora*, *Anogeissus latifolia*, *Terminalia tomentosa*, *Xylia xylocarpa*, *Grewia tiliacifolia* and *Stereospermum xylocarpum*.

(g) A study of the effect of corrosive chemicals on wood was also started in conjunction with the Seasoning Section. Some preliminary strength tests were made on deodar. The study is being continued.

(h) Tests on tea chests of hollock and hollong received from Messrs. The Assam Saw Mills and Timber Co., Ltd., were made to find out the strengths of different thicknesses of plywood considered suitable for tea box work. A report was made.

(i) Wood used in aircraft construction and also wood from wooden parts damaged in accidents were tested from time to time as required.

(j) 22 consignments of glue joints submitted by Ground Engineers of the various Flying Clubs in India for their licence examination were examined and reported on to the Director of Civil Aviation.

(k) Work was started on the preparation of grading rules for Andaman padank. A preliminary tabulation of defects for 675 squares has been done. The work is at present held in abeyance pending the visit of the Officer in Charge, Timber Testing Section, to the Andamans, for making a mill study and obtaining first hand information about the nature of the logs available in the forests.

### ROUTINE TESTING.

During the year under report, attention was concentrated on work under Project 1 (standard tests on small clear specimens) as it had fallen in arrears. It will be seen from the following list of species tested that good progress was made. Tests under Project 2 (standard tests on structural timbers) were continued. Other routine testing on glues, plywood, containers, etc., was also kept up-to-date in cooperation with the Woodworking Section.

#### NUMBER OF SPECIES TESTED DURING THE YEAR.

		Green.	Air dry.	Kiln dry.	Misc.
Project No. 1	. .	17	13	16	..
Project No. 2	. .	..	3	..	..
Project No. 0	. .	..	under all heads		77

The 77 consignments under Project 0 include the 22 consignments of glue joints submitted by Ground Engineers for their licence examination.

## NUMBER OF SPECIES COMPUTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Misc.
Project No. 1 . . .	9	12	7	..
Project No. 2 . . .	..	4	..	..
Project No. 0 . . .	..	under all heads		78

About 18,000 mechanical tests and nearly the same number of physical determinations were made during the year. About 4,000 special shrinkage observations were also made in addition to the routine testing.

## TECHNICAL NOTES AND ADVICE.

About 100 technical notes and letters were issued during the year among which the following may be mentioned :—

1. Comparison of sissoo (*Dalbergia sissoo*) from different localities.
2. Comments on B. S. Draft Specification for Testing Glues.
3. Comments on B. S. Draft Specification for Testing Timbers (small clear specimens).
4. Indigenous substitutes for Sitka spruce for the manufacture of air craft.
5. Indigenous substitutes for hickory.
6. Indigenous substitutes for boxwood.
7. Indigenous substitutes for cornel wood.
8. Wood for picker arms.
9. Wood for spinning rollers.
10. Wood for reels and bobbins.
11. Wood for shuttles.
12. Wood for combor boards.
13. Wood for brushes.
14. Wood for Army signal sticks.
15. Wood for skating hall floors.
16. Wood for hoops of drums.
17. Wood for musical instruments.
18. Wood for laminated tennis racquets.
19. Wood for boat building and dugouts.
20. Wood for hammer handles and shovel handles.
21. Wood for skis.
22. Wood for bridge chesses for military pontoon bridges.

## Wood Seasoning Section.

### 1. NEW PROCESS OF KILN DRYING.

Experiments on the new process of kiln drying developed at this Institute were continued during the year, and although the number of kiln charges in the large-sized kilns were only six, on account of insufficient supplies of timber for the purpose, the results obtained in all cases were highly successful. Some details about the timbers kiln-dried during the year are given below :—

(i) *Cedrela toona*, toon.—Nineteen logs of this species were received from the Divisional Forest Officer, Buxa Division, Bengal. The logs at the time of receipt were fairly straight and cylindrical, and, except for some slight heart and radial shakes, were in good condition. It was found that shakes, particularly the radial ones, were liable to develop considerably if the logs were stored on land for any length of time, and for this reason it is advisable to convert the logs as soon as possible after felling and to season the converted material immediately. The period required for kiln drying from about 80 per cent. to 8 per cent. moisture content was about 10 days, and the degrade during drying was much less than that which has been experienced with local toon from roadside trees. Bengal toon is not liable to warping and collapse to any noticeable extent and is fairly free from knots, and the seasoned material on the whole presents a much more attractive appearance than local toon.

(ii) *Terminalia bialata*.—The sapwood of this species is known as white chuglam, and the heartwood as silvergrey wood. The wood lends itself readily to the process of kiln drying. A charge of one inch thick planks varying in widths upto 25 inches was kiln dried in an internal fan, reversible circulation kiln. The moisture content of the wood was reduced in less than 9 days from 60 per cent. to about 9 per cent., with no increase in degrade, except for some opening out of shakes originally present in the heartwood. The following schedule can be recommended for the kiln drying of this wood :—

Cycle.	AVERAGE MOISTURE CONTENT OF THE WOOD.			
	From green to 35 per cent.	35 per cent. to 20 per cent.	20 per cent. to 12 per cent.	12 per cent. to 8 per cent.
Maximum temperature .	50°C.	50°C.	52°C.	55°C.
Heating with air circulation .	30 min.	30 min.	30 min.	45 min.
Cooling with air circulation .	{ 1 hr. 25 min.	{ 1 hr. 30 min.	{ 1 hr. 30 min.	{ 2 hrs. 15 min.
Exhaust . . . . .	5 min.	Nil	Nil	Nil

A slight humidity treatment at the end will relieve any stresses produced during the process of drying. Although a maximum temperature of 55° C. is recommended in the above schedule, the timber was found to stand a much higher temperature (up to 80°C.) in the Furnace kiln (see below) without any apparent injury. If higher temperatures are employed, it is essential that the circulating air should be kept well humidified, for which purpose the kiln walls should be built of a material practically impervious to moisture. A small kiln with heating coils, fan circulation, water sprays for humidification, and a metal lining to prevent moisture leakage, is now in course of construction at Dehra Dun, and it is hoped that the effect of drying some refractory hardwoods at very high temperatures will be tested out during the next year.

(iii) *Adina cordifolia*, haldu. Very wide planks of this wood, a little over one inch in thickness, were dried from about 56 per cent. to 10 per cent. moisture content in 10 days, with no appreciable degrade at all. In a few planks, original shakes opened out slightly and some knots were found to have split during the process of drying, otherwise the condition of dried material was noted as very good.

With this wood, a slightly longer cooling period was found to be useful, and a maximum temperature of 61° C. was found to have no adverse effect.

(iv) *Canarium euphyllum*, white dhup. Planks,  $\frac{3}{4}$  inch thick, were kiln dried from about 60 per cent. to 10 per cent. moisture content in 8 days by the new process in an internal fan kiln. The condition of dried material was good, and the period of drying could probably have been reduced by making the drying conditions severer. The results on the drying of this wood in the Furnace kiln are described below.

(v) *Terminalia tomentosa*, laurel. A charge of one inch thick planks of this wood was dried in an internal fan kiln by the new process, the timber requiring a period of 14 days for drying from about 80 per cent. to 9 per cent. moisture content. Part of the timber was very dark coloured, from a consignment received from Madras, and this came out of the kiln after drying in an almost perfect condition. The rest of the timber was from Dehra Dun forests and was of a much lighter colour with a large amount of sapwood. This wood had numerous original heart-shakes and knots, and it was noticed that the heart-shakes had opened out in some planks and there was collapse around the knots which had split in almost all cases.

## 2. SMALL LABORATORY KILNS.

The two small kilns were kept going throughout the year, drying 24 charges of timber of 19 species, mostly for the Timber Testing Section.

Kiln drying of *Shorea robusta* (sal) was tried in two charges, but with no better success than before. Some of the woods like *Schima wallichii*, *Planchonia andamanica*, *Bridelia retusa*, and *Heritiera* spp. were found to be extremely refractory to kiln dry. These small kilns have now been re-designed, and 4 new chambers of the new design are in course of construction.

### 3. FURNACE KILN.

Seven charges of timber were dried in this kiln, and the results in all cases were highly gratifying. A detailed report on the results obtained with this kiln is in the press (*Indian Forest Records, Utilization*, Vol. I, No. 3), but a short article on the subject was published in the *Indian Forester* of March 1936, as a result of which a number of enquiries were received asking for details of construction of the kiln. A kiln of this type can be built for less than Rs. 2,000 in this country, and since it is easy to operate and the cost of drying is low, it is to be expected that it will become popular with small scale cabinet and furniture makers.

### 4. AIR SEASONING.

A large number of logs of miscellaneous species, which had been accumulating in the log ponds for a number of years, and which were not required for any particular investigation, were cut up into planks and scantlings and stacked for air-seasoning during the year. In all, 36 species were stacked and are being kept under observation for the determination of air seasoning characteristics.

The experiment on the air seasoning of some highly refractory species, which was started last year, and in which the planks were stacked with thin crossers and even without crossers, in order to slow down the rate of drying, showed conclusively the necessity of using crossers for stacking wood for air-seasoning. The material stacked without crossers remained wet even after one year, except at the ends which showed severe cracking and splitting due to the unequal rate of drying. The use of thin crossers, about  $\frac{1}{2}$ " thick, for stacking highly refractory woods for air-seasoning appears to be promising and will be further investigated.

### 5. WATER SOAKING PRIOR TO AIR SEASONING.

Strength tests on end-matched specimens of various species, which had been air-seasoned with and without previous water soaking showed that in the case of *Anogeissus latifolia* there was a slight decrease in the strength of wood under impact, while there was no marked effect in the case of *Grewia tiliaefolia*, *Xylia xylocarpa*, *Terminalia tomentosa* and *Stereospermum xylocarpum*. Tests on other species are in progress.

## 6. AIR SEASONING OF RAILWAY SLEEPERS.

A report giving details of and results obtained from the various experiments on the air seasoning of coniferous railway sleepers carried out in the Punjab between 1926 and 1934 was published during the year (*Indian Forest Records, Utilization*, Vol. I, No. 2). This Record contains a discussion on the results and also some suggestions for the improvement of the softwood sleeper situation in North India.

A small experiment was started at Marala in the Punjab, in co-operation with Messrs. Spedding Dinga Singh & Co., to test the effect of girdling standing trees of deodar for 2 years before felling, with special reference to the subsequent cracking and splitting of sleepers during seasoning. Two lots of deodar sleepers were stacked, one from girdled trees and the other from the same forest area but from trees which had not been girdled. The stacking was done in the first week of January 1936, and the final inspection was carried out in March 1936. The results are being worked out, but there appears to be no marked improvement in the seasoning of sleepers from girdled trees.

In order to determine the extent of drying of deodar wood during the period the trees are left standing after girdling, two trees of deodar were girdled in the Chakrata division in the United Provinces, and a detailed investigation will be carried out on the air seasoning of sleepers obtained from these trees.

## 7. DETERMINATION OF THE MOISTURE CONTENT OF WOOD.

Two papers on this subject were published during the year, one in the *Empire Forestry Journal* (Vol. 14, pp. 43-53, 1935) and the other in the *Indian Forester* (July 1935). From the numerous enquiries that are being received on the subject of rapid methods of determining moisture in wood, it appears that there is a growing demand in this country for electric moisture meters. The imported instruments are very costly, requiring an investment of Rs. 800 to Rs. 1,500 for each meter, and there appeared to be little chance of their becoming popular in this country at such prices.

With the object therefore of devising a cheap and efficient electric moisture content indicator for general and commercial use, various methods of measuring electric resistance of wood have been studied in the seasoning laboratory, and a moisture meter based on the conductivity principle using a thermionic vacuum tube amplifier and a special type of needle contacts has been constructed. The amplifier works at a low voltage and is used under conditions which cut down to a minimum the sources of trouble in the grid circuit, which are usually met with in the amplification of minute currents. An instrument of this type can be built up at a cost of about Rs. 150, most of the components being avail-

able from radio dealers. A detailed note on the subject will be published soon when the new meter has been thoroughly tested.

### 8. A SURVEY OF THE MOISTURE CONTENT OF WOOD.

No definite information is available at present on the seasonal variations of the moisture content of wood and consequent changes in size due to shrinkage and swelling of wood ; and it was, therefore, considered desirable to collect information on this subject. Matched specimens of six commercially important species were prepared at Dehra Dun, and were distributed to 22 different centres spread all over the country, where the specimens will be weighed and measured regularly every fortnight for a period of two years. The information obtained will be of considerable use to railways, cabinet and furniture makers, and others interested in the use of seasoned wood.

### 9. SHRINKAGE STUDIES.

Experiments on the effect of high temperatures on the shrinkage and moisture equilibrium of wood were completed during the year, and a report was issued as an *Indian Forest Record* (Utilization, Vol. I, No. 1). The following treatments have been investigated :—

- i. Kiln drying.
- ii. Steaming of green wood at and above atmospheric pressure.
- iii. Boiling of green wood in water.
- iv. Steaming of air dried wood at atmospheric pressure.
- v. Exposure of wood to dry air at 100°C.

The results are fully discussed in the report, but the main conclusion drawn from the experiments is that within practical limits the use of high temperatures alone is incapable of reducing the shrinkage, swelling and hygroscopicity of wood by any appreciable amount.

A detailed investigation is now in progress on the effect of impregnating wood with various chemical substances on the shrinkage and swelling of wood, but the results so far have not shown any marked reduction in the working of wood with fluctuations in atmospheric humidity, although a large number of treatments recommended in current literature have been tried.

An experiment was carried out on the metal spraying of wood, with a view to finding out how far a film of metal sprayed on a piece of wood would protect it against changes in moisture content and dimensions due to variations in atmospheric humidity. It was found that metals having low melting points, like tin, lead and zinc, reduced this property by about one half to one third, whereas the metals melting at

higher temperatures did not show any appreciable effect. Further, the sprayed metal coatings do not protect wood against the absorption of water during the soaking of such treated pieces in water, and there is a liability of weakening the bond between the wood and the metal due to the swelling and shrinkage of the wood. The results are given in detail in the *Indian Forester* of October 1935.

#### 10. COLLAPSE IN WOOD.

The investigation on the occurrence of collapse in certain Indian woods and methods for its removal was completed during the year and a report was published in the *Indian Forester* of November 1935. With regard to the incidence of collapse in wood, it was found that—

- i. The tendency to collapse varies in different trees even among those growing in the same locality,
- ii. The material from the butt end is more prone to collapse than that from the top of a tree,
- iii. Heartwood from near the sapwood zone has greater liability to collapse than wood near the heart-centre,
- iv. The severity of collapse is increased by drying at high temperatures in a kiln, and
- v. That the first appearance of collapse is noticed at about 50 per cent. to 60 per cent. moisture content and most of the collapse occurs before the wood reaches the fibre saturation point.

Experiments on the steaming of collapsed wood at about 100°C. for periods varying from one to six hours showed that collapse can be removed almost entirely from wood planks, but the same treatment was not effective in the case of *Schima wallichii* and *Quercus lineata* and only partly so with *Acrocarpus fraxinifolius* and *Machilus* spp.

#### 11. END PAINTS.

Various tests are in progress on the suitability of different compositions for use as end-paints on converted material for preventing end-splitting of wood during air seasoning. The results so far show that thick coal tar is nearly as effective as some of the paints specially made for the purpose such as hardened gloss oil, while it costs much less. It is already proving useful for preventing excessive end-splitting of soft-wood railway sleepers in the Punjab.

#### 12. ENQUIRIES.

A large number of enquiries on various subjects relating to air and kiln drying of timbers were replied to as usual. Designs for small timber

drying kilns were supplied to various firms, and a number of enquiries on the design and construction of Furnace kilns are in hand. These will be dealt with as soon as the final plans for this kiln are ready.

### 13. STAFF.

Dr. D. Narayanamurti, an Upper Grade Assistant in the Section, returned to duty after spending about a year at Danzig University, where he obtained the degree of Doctor of Engineering, on a thesis on the movement of moisture in wood.

## Wood Preservation Section.

### 1. LARGE SCALE FIELD EXPERIMENTS WITH ASCU BY THE INDIAN RAILWAYS.

In accordance with the recommendations of the Raman Committee, the North Western Railway treated under pressure with Ascu 10,000 sleepers of chir, fir and deodar. The sleepers were also given a supplementary dipping treatment with a bituminous suspension of petroleum asphalt and crude oil.

### 2. RELATIVE COST OF THE ASCU AND ANTI-SPLITTING TREATMENT AND THE PRESENT CREOSOTE AND CRUDE OIL TREATMENT OF RAILWAY SLEEPERS.

The 10,000 sleepers referred to in the previous paragraph were treated by the Ascu Wood Preserving Agency, Dehra Dun, who put up their up-to-date portable Ascu treating and anti-splitting plants in the sleeper treating yard of the North Western Railway at Dhilwan. Half the sleepers were treated with a 4 per cent. Ascu solution in water and the rest were treated with an 8 per cent. Ascu solution. All the sleepers were given, after a few days air-seasoning, a dipping treatment with a hot bituminous suspension.

The Raman Committee has stated (*vide* para. 10 of the Report) that "A 40 per cent. solution of creosote which is usually regarded as an excellent preservative proved wholly unable to resist the destructive agents acting on a sheet of *Bombax* veneer when interred in the graveyard. In the same circumstances, however, a 4 per cent. solution of Ascu showed itself completely effective as a resistant to fungus and insect attacks".

It may be stated in this connection that although the North Western Railway have been employing a 40-60 mixture of creosote and fuel oil for treating softwood sleepers, the quantity actually impregnated is

only 5 lbs. per cubic foot whereas with Ascu, a 20 per cent. larger quantity of 4 per cent. solution is injected. The following estimate of costs has been based on an absorption of 6 lbs. of 4 per cent. Ascu solution per cubic foot into softwood sleepers followed by the anti-splitting treatment. It is due to the courtesy of the Ascu Wood Preserving Agency that the following reliable figures of the actual cost of Ascu and anti-splitting treatment of sleepers have been made available for publication.

*Capacity, working only single shift, of the whole plant (using Rueping process) 180 B. G. sleepers.*

(Working days in the year—300.)		Rs. a. p.
1. Capital cost—		
Interest on investment at 5 per cent. Depreciation at 7½ per cent. . . . .		0 0 3
2. Cost of treating substances—		
(a) Ascu chemicals at 0.7 lb. per sleeper based on an impregnation of 6 lbs. of solution per cu. ft.		0 3 6
	(Will be slightly less for the Railway due to less freight charges.)	
(b) Anti-splitting medium (10 per cent. asphalt in unrefined crude oil 4 lbs. per sleeper) . .		0 2 0
3. Cost of labour and supervision (including handling sleepers during and between the operations)—		
(a) Ascu treatment . . . . .		0 0 10
(b) Anti-splitting treatment . . . . .		0 0 4
4. Power and fuel—		
(a) Power (crude oil and lubrication for oil engine) .		0 0 2½
(b) Fuel for heating anti-splitting medium . .		0 0 1½
5. Miscellaneous Stores . . . . .		0 0 1
TOTAL .		0 7 4

The corresponding cost of the present treatment at Dhilwan with a 40 per cent. creosote—60 per cent. crude oil mixture and using 5 lbs. of the mixture per cu. ft. works out at about Rs. 1-0-8 *excluding* the cost of carriage of sleepers from different places to the central treating plant located at Dhilwan. Even at special railway material rates, the transportation charges are considerable. In the case of the most important kind of coniferous sleepers, namely chir sleepers, the North Western Railway has been paying a freight charge of about 0-9-0 per sleeper on two to three lakhs of chir sleepers treated annually; on blue pine and fir sleepers, the railway also spends annually about two lakha rupees on freight.

The above facts indicate clearly the superiority of a cold treatment process like that with Ascu which makes an inexpensive portable pressure and power plant practicable. The Ascu Wood Preserving Agency has stated that their complete plant, which can deal by the Rueping Process with about 1,10,000 sleepers a year, cost only Rs. 7,500. It can be carried and installed anywhere at very small expense. No boiler or other heating is required for the treatment. Other smaller plants are available at about Rs. 1,500 and upwards.

### 3. SPECIFICATIONS FOR ASCU TREATING WOOD POLES FOR ELECTRIC TRANSMISSION.

During the year, detailed specifications for the Ascu treatment and seasoning of wood poles were worked out as there was a considerable demand for the treatment of wood poles with Ascu. Such specifications have since been supplied to the heads of several departments of the different provinces. The Hydro-electric departments of the United Provinces, the Punjab and the North-West Frontier Province, have decided to use for all their 11 K. V. distribution lines only wood poles treated with Ascu. Several towns in the Punjab, United Provinces, and Bihar also have either decided to or will very probably decide to use wood poles treated with Ascu for electric lighting and service.

### 4. SPECIFICATIONS FOR THE PURCHASE OF WOOD POLES FOR OVERHEAD TRANSMISSION.

Considerable correspondence took place between the Forest Research Institute and several local Governments and public utility concerns regarding the framing of suitable specifications for the purchase of untreated wood poles meant for subsequent antiseptic treatment. Provisional specifications have been drawn up, and considerable help has been given to enquirers regarding the design of wood poles and the framing of specifications for the purchase of wood poles. These specifications will be further discussed in the near future by the Officer in Charge, with the Electric Inspectors of the various provincial governments so that they will, in all probability, have to be modified slightly at a future date.

### 5. PRACTICAL APPLICATIONS OF ASCU.

(a) During the year, there were six Ascu pressure treating plants under operation. The Ascu Wood Preserving Agency, Dehra Dun, treated nearly 6,000 wood poles under pressure with Ascu for the Hydro-electric Department of the Government of the United Provinces. It is understood that all the poles have been erected, and the department is thoroughly satisfied with them. Compared with the corresponding estimate employing one of the cheapest and most unsatisfactory type

of metal pole (namely steel rails) a saving of over a lakh of rupees has resulted during the year to the Government of the United Provinces, by using treated wood poles. The saving when compared with the usual and more expensive types of imported metal poles is far greater.

The Hydro-electric Department have recently placed a further order with the Forest Department of the United Provinces, for 5,000 more sal poles which will be treated shortly with Ascu under pressure. In a few months' time, therefore, in a single province a high tension transmission line of about 700 miles in length supported on treated wood poles will be an actual fact.

(b) The services of the Officer in Charge of the Section were lent to the Government of Bhopal for examining the timber resources of the State. Several recommendations to the Government for the more economical, extensive and scientific exploitation of the State's timber resources were made. Most of the proposals hinge on the high degree of durability that can be obtained by treating practically any timber with Ascu. It is understood that two of the most important recommendations made, namely the installation of a high tension transmission line from Bhopal to Sehore and the erection of a comprehensive telephone system, (linking the various Tehsil headquarters with the city of Bhopal) have been very favourably considered by the State authorities. By employing treated wood poles, it has been made possible to construct a telephone system of the metallic two-wire type for only Rs. 150 per mile. There is a great field, especially in the Indian States, for the inauguration and extension of economical and efficient telephone lines employing treated wood poles as they cost only a small fraction of the price of metal poles.

(c) As a result of the excellent results obtained with some experimental Ascu treated posts placed in the various harbours of India, the Cochin harbour authorities have decided to put up very shortly an Ascu treating pressure plant, and the harbour authorities of Calcutta, Vizagapatam and Bombay have been considering seriously the question of putting up similar plants to preserve timber for marine construction work.

(d) During the year the Government of Travancore purchased a pressure treating plant and made it ready for preserving with Ascu all the poles required in connection with the Pallivasal Hydro-electric Scheme, and for building construction, etc. One of their officers was deputed to Dehra Dun in July 1935 for two months' training in wood preservation.

(e) The Government of Mysore also treated several thousand cubic feet of timber with Ascu during the year and have decided to continue such treatment for electric poles, sleepers, building timber, etc.

(f) The Hydro-electric Department of Simla treated a few hundred locally obtained coniferous poles with Ascu by a dipping treatment. It is understood that they will use Ascu treated poles in all their future work.

(g) It has already been mentioned that during the year under review six Ascu treating pressure plants were in operation. It is further understood that at least ten more pressure plants will be put up at different points in India during the next few months, so that it is not perhaps too optimistic to hope that commercial wood preservation will very soon become an important industry in this country.

(h) A 2 per cent. solution of Ascu was used to treat *Tamariz* stakes in tomato plantations in the North-West Frontier Province. The annual renewal of untreated stakes due to white-ant attack was costing previously about Rs. 60 per acre. After over a year's experience it has been reported that not a single Ascu treated stake required renewal and the Director of Agriculture expressed the opinion that Ascu was definitely suitable for agricultural requirements.

(i) On the advice of the Forest Research Institute, the Government of the Federated Malay States have finally decided to put up a pressure Ascu plant to treat railway sleepers, and they have placed the order for it.

(j) A pressure plant employing Ascu was also put up by a private firm in Ceylon on the advice of the Dehra Dun authorities.

## 6. TREATMENT OF BAMBOOS WITH ASCU.

Experiments conducted with split and unsplit bamboo using Ascu under pressure showed that there was hardly any difference in the amount absorbed by the two types. It would appear, therefore, that the penetration in bamboos is practically wholly longitudinal, and that the nodes hardly interfere at all with the penetration.

There is a great field for the extensive use of treated bamboos in India. Very large quantities of bamboo are used in cheap house construction, for mats, partitions, roofing, and ceilings. Untreated bamboos rot or are attacked by insects in a few months. Treated bamboos are durable and resistant to white-ant, insect and fungus attack for a period of over three years when exposed to very severe conditions promoting decay and insect attack, so that under average conditions of use, a far longer average life can be confidently expected.

The importance of the use of treated bamboos and timber can be appreciated from a report that about seven lakhs of bamboos are required for renewal purposes annually in a single sugarcane district in Madras Presidency. It has been computed that the annual cost of renewing bamboo props in sugarcane fields works out at about Rs. 40 per acre.

## 7. NATURAL DURABILITY OF CERTAIN TIMBERS AND THE TOXIC PRINCIPLES INVOLVED.

Aqueous, ethereal and alcoholic extracts of sal, deodar, teak and jack wood were prepared for treating semul veneers to see whether such extracts have any antiseptic value for preserving timber and, if so, to study the true nature of the toxic principles of the four timbers in question that confer on them the property of resisting decay and insect attack.

One inch cubes of sal, teak, deodar and rosewood were also shaken 20,000 times in a shaking machine with ether, hot water and a 5 per cent. caustic soda solution. Similar pieces were also left exposed to a temperature of 80°C. for 6 hours. All the pieces after the above different treatments were submitted to termite and fungi tests in the antiseptic test yard. The results of these tests will be reported next year.

## 8. FIREPROOFING TREATMENT OF TIMBER.

Ammonium salts, especially ammonium borate, ammonium sulphate and ammonium phosphate, have been long known as efficient and comparatively cheap fireproofing agents for timber. Efforts to incorporate these with Ascu have not proved wholly successful. Experiments were conducted to examine the effect of the addition of sugar to reduce the corrosive action of Ascu and ammonium sulphate on steel. While there was an improvement the defect could not altogether be eliminated, so that a search has still to be made for an economical and efficient fireproofing composition that can be incorporated with Ascu for pressure treatment in one movement. It may be stated, however, that for short periods of time the addition of sugar has been found to be very effective for making a combined Ascu and ammonium sulphate treatment practicable.

Fireproofing paints of three colours namely white, blue and brown were prepared. These will be improved during the coming year when a special apparatus for testing the relative fireproofing efficiencies of different compositions will be installed.

## 9. ANTI-SPLITTING TREATMENTS.

During the year under review experiments were conducted to find out the best conditions of moisture content for the anti-splitting treatment of sleepers. The experiments indicated that in the case of softwood sleepers, certain improvements in the reduction of a tendency to split might be expected by employing a dipping or pressure treatment with an aqueous emulsion of asphalt of a penetration of 180 to 200. In the case of hardwood sleepers however an oil or asphaltic treatment is practically of no value as far as reduction of splitting is concerned.

Six different types of petroleum asphalt, air-blown and steam blown, and of different degrees of penetration, were submitted to test to determine their relative water-proofing efficiency. An asphalt with a penetration of 30 to 40 appeared to be about the best. This fact will be made use of for developing water-proof wood shingles, and for water-proofing plywood.

Emulsions of asphalt with water and with sodium silicate solution were tested to find out their relative water-proofing efficiency. Sodium silicate appears to improve the water-proofing efficiency of an aqueous asphaltic emulsion. A classification of condition was made as regards the splitting, of several Ascu treated sleepers of six species, viz., chir, fir, kail, deodar, bollong and hollock. They were given a supplementary anti-splitting treatment by pressure in the case of half the sleepers and by dipping in the case of the rest. The sleepers were then exposed to the elements for 14 months when they were inspected individually and their conditions classified. An independent inspection and classification of the same sleepers was made by the Permanent Way Inspector, Dehra Dun. His classification tallied closely with that of the Institute experts. Both the classifications showed that sleepers dipped in a bituminous suspension of asphalt and crude oil were in a better condition as regards splitting than the corresponding sleepers treated under pressure with the same anti-splitting composition. The fact that some of the pressure treated sleepers containing 3 to 4 gallons of the composition per sleeper split very badly raises an important point as to whether a large quantity of dark coloured oil does not increase the tendency of sleepers to split in the permanent way. This is being investigated.

#### 10. ASCU TREATMENT OF TIMBER IN SITU.

In practice there are several places where untreated timber has been already used, or where facilities for pressure treatment may not be readily available. Experiments to develop a special asphaltic emulsion with Ascu have been inaugurated, and it is expected that during the coming year a painting composition will be perfected which can be applied with a brush to timber already in use.

#### 11. DESIGN OF A CHEAP PORTABLE WOOD PRESERVATION PLANT.

A design for an inexpensive portable wood preservation plant for use with a preservative like Ascu (which requires no heat for its application) was developed during the year and was placed at the disposal of several enquirers who asked for such a plant. A small Ascu pressure plant can be had for as low an investment as Rs. 300. Such a plant can deal with several thousand cubic feet of wood in a year. Its manipulation is very simple. It requires no special technical knowledge and no

power. Manual labour can operate a hand pump which is all that is required for developing the necessary pressure.

## 12. MARINE TESTS.

All the Ascu treated experimental sticks laid down in the harbours of Calcutta, Vizagapatam, Madras, Cocbin, Bombay and Ksrachi were inspected by the Chief Engineers concerned during the year, and were found to be, *in all cases*, in excellent condition. Some of the treated pieces had been exposed in teredo infested waters for about three years. As the wood in question consisted practically entirely of rapidly perishable sapwood and as even teak heartwood has been known to have been destroyed within a year by marine organisms, the results obtained with Ascu treated sapwood pieces have been very gratifying.

## 13. GRAVEYARD TESTS.

During the year sticks treated with Cuprinol, Orthodichlorobenzene, Ascu asphalt emulsion and Saum's preservative were placed in the test-yard, and kept under observation. Creosoted bamboos, insulation boards and treated plywood specimens were also laid in the test-yard for tests against termites and fungi. Untreated specimens of the following species were also submitted to test in the test-yard:—

*Isonandra* spp.

*Kayea floribunda*.

*Amoora rohituka*.

## 14. TESTS BY ELECTRIC INSPECTORS.

Ascu treated posts and untreated controls were sent to practically all the provincial Electric Inspectors in the country for test purposes. In the case of two provinces, tests are also being undertaken by Electric Supply Companies.

## Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other sections, while the Officer-in-Charge (Mr. W. Nagle) devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 18,829 wood specimens for test purposes as detailed below:—

### Static Bending:—

Aircraft 1-A . . . . .	195
Research 1-R . . . . .	198
Regular 1-R . . . . .	1,279
Vehicle Minor 1 VM . . . . .	912
Plywood 1 P. W. . . . .	239

<b>Impact Bending—</b>		
Special . . . . .		503
Regular 2 . . . . .		810
Royal Aircraft 2RA . . . . .		4,102
<b>Compression Parallel—</b>		
Structural 3str. . . . .		69
Regular 3 . . . . .		2,325
<b>Compression Perpendicular—</b>		
Structural 4str. . . . .		28
Regular 4 . . . . .		770
Hardness—5 . . . . .		699
<b>Shearing—</b>		
Regular 6 . . . . .		3,346
Plywood 6 P. W. . . . .		661
Glue joints 6 J. B. . . . .		107
Tension Perpendicular to grain—7 . . . . .		826
Torsion—8 . . . . .		590
Shrinkage Radial and Tangential—9 . . . . .		748
Shrinkage Volumetric—10 . . . . .		374
Boxes . . . . .		24
Hammer handles . . . . .		24

The Wood Technology Section was supplied with 34 "Gamble" specimens and 993 band specimens.

In addition to supplying other sections with converted material for research purposes this Section completed 438 jobs of a varied character including the making of:—

- Handles (various).
- Packing cases (various).
- Ladders.
- Parquet flooring.
- Drawing boards.
- T. Squares.
- Switch board covers.
- Frames (various).
- Sign boards.
- Almirahs.
- Tables.
- Curtain rods and brackets.
- Cupboards.
- A saw bench.
- Veneer and plywood panels.
- File cabinets.

Machine platforms.

Tennis racquets (experimental).

Camera frames.

Experimental bridges.

Flooring.

Boxes (various).

Screens.

Glue test joints.

Stools.

Racks.

Veneer boxes.

Trays (various).

Five hundred and forty-four logs of 79 species were converted in the sawmill.

In addition to the above much miscellaneous work was done in the mills such as preparation of crossers for stacking timber planks and scantlings for use in other Sections.

Reports on the working qualities of the undermentioned timbers were recorded during the period under review :—

*Bombax malabaricum.*

*Tectona grandis* (Bengal, air dry).

*Lagerstroemia lanceolata.*

*Mimusops elengi.*

*Morus alba.*

*Tectona grandis* (Bengal, kiln dry).

*Anthocephalus cadamba.*

*Tectona grandis.*

*Sterculia campanulata.*

*Dalbergia sissoo.*

*Dalbergia sissoo* (Punjab roadside).

*Dalbergia sissoo* (knotty sissoo).

*Eucalyptus eugenioides.*

*Dalbergia sissoo* (Bengal, air dry).

*Dalbergia sissoo* (Bengal, kiln dry).

*Morus alba.*

*Cinnamomum iners.*

*Carallia integerrima.*  
*Chukrasia tabularis.*  
*Tectona grandis* (Madras).  
*Vitex altissima.*  
*Dalbergia sissoo* (Nepal).  
*Amoora rohituka.*  
*Shorea robusta.*  
*Dichopsis polyantha.*  
*Kayea floribunda.*  
*Calophyllum* spp.  
*Heritiera* spp.

#### Tests.

Tests were carried out on a sample piece of plywood forwarded by Messrs. The Expanded Metal Depot, Bombay.

Tests were carried out on a piece of teak which was prepared for the purpose of ascertaining if "Ducc" would react in any way to the various chemicals peculiar to photographic work.

Tests and a careful examination were carried out on a folding boat sent to the Institute by the K. G. O. Bengal Sappers and Miners, Roorkee, and the results with advice and suggestions for improvements in the design were given.

#### Miscellaneous.

At the request of the Officer Commanding, K. G. O. Bengal Sappers and Miners, Roorkee, the Officer in Charge, Wood Workshop Section, visited their works to give help and advice on their sawmill.

Experimental bridges of laminated construction were made in the workshop and are now under observation.

The laurel screen made in the wood workshop of this Institute and exhibited at the Bihar and Orissa Forest Department stall at the Patna Exhibition won a silver medal and a certificate of merit.

Experimental veneer fruit baskets were made at the request of the Marketing Board authorities for trial.

#### Veneer Sub-Section.

Logs of the following species were peeled for tests under Project VIII :—

*Dipterocarpus tuberculatus.*  
*Tetrameles nudiflora.*

*Gmelina arborea.*

*Aglaia odoratissima.*

*Elaeocarpus tuberculatus.*

*Cedrela toona.*

*Amoora canarana.*

*Litsaea wightiana.*

*Palaquium ellipticum.*

*Bucklandia populnea.*

*Ougeinia dalbergioides.*

*Pterocarpus marsupium.*

*Tetrameles nudiflora.*

*Cryptomeria japonica.*

*Artocarpus chaplasha.*

*Terminalia bialata.*

*Shorea assamica.*

*Canarium euphyllum.*

*Bombax malabaricum.*

Enquiries relating to veneers and plywood received during the year included the following :—

1. The Chief Conservator of Forests, Mysore, regarding a plywood factory in India and machinery for making plywood, etc.
2. Mr. Stanley A. Clarke, Council for Scientific and Industrial Research, Melbourne, regarding details of a plywood plant with sketches and full information on the subject.
3. The Director, Industrial Intelligence and Research Bureau, New Delhi, regarding a plywood plant for the manufacture of packing cases and chair seats.
4. Mr. R. K. Jain, Civil Engineer, Delhi, regarding particulars and sizes of machines for the manufacture of plywood.
5. The Forest Research Officer, Bihar and Orissa, regarding the cost of veneer panelling.
6. The Timber Manager, The Assam Railways and Trading Co., Ltd., regarding lac adhesives.

Visitors to this Section were numerous.

#### **Minor Forest Products Section.**

F. R. I. PORTABLE CHARCOAL KILN ("FRIKILN").

The number of enquiries concerning this kiln continued to be large. Thirty-five sets of scale drawings of the kiln were sent out to forest

officera and charcoal contractors who wished to make their own kilns. The forest departments of various provinces and states in India, the Federated Malay States, Mauritius and the United States of America were among those to whom the drawings were supplied.

Experiments were continued to see if it was possible to do away with certain parts without sacrificing the efficiency of the kiln, so that the cost of the kiln could be reduced. It was found however that substantial reductions were not possible without changing the design of the kiln.

## 2. CHARCOAL BRIQUETTING.

The cost of manufacturing charcoal briquettes using various binders was worked out, and the search for a cheap binder was continued. Of the various binders tried the following gave good results:—(i) 5 per cent. *Bauhinia retusa* gum and 4 per cent. rice, (ii) 5 per cent. rice, (iii) 6 per cent. *Bauhinia retusa* gum. With these binders the cost of briquetting per maund of 80 lbs. of briquettes works out at Rs. 0-8-2 for (i), Rs. 0-3-11 for (ii) and Rs. 0-7-0 for (iii). On a commercial scale (ii) holds out promises of being successful.

Tamarind seeds ground and boiled in water, and prickly pear (*Opuntia* sp.) were also tried as binders. The former gave good strong briquettes which burnt well, while the latter produced weak briquettes which, however, also burnt very well.

Some preliminary experiments were also made on the use of molasses as a binder. The briquettes were very strong but they absorbed moisture during the monsoon. The future line of work will be to find if possible a suitable binder from waste products of little or no value.

## 3. CULTIVATION OF MEDICINAL PLANTS.

The following species were cultivated in the Minor Forest Products garden:—(1) *Datura fastuosa*, (2) *Ipomoea purga*, (3) *Tribulus terrestris*, (4) *Artemisia maritima*, (5) *Chrysanthemum cinerariaefolium* (Pyrethrum), (6) *Derris elliptica*, (7) *Derris malaccensis*, (8) *Solanum indicum*, (9) *Hydrocotyle asiatica*, (10) *Plantago psyllium*, (11) *Plantago obovata*, (12) *Mentha piperata*, (13) *Carum copticum*. Of these, numbers (1), (4) (Kashmir variety), (8), (9), (10), (11), (12), (13) were successful. Numbers (2), (6) and (7) did not like the Dehra Dun climate.

During the year seeds and cuttings of *Artemisia maritima* were supplied to the Silvicultural Research Division, Punjab, for trial at Chichawatni.

Pyrethrum powder, prepared from the flowers grown in the Minor Forest Products garden, was found by the Forest Entomologist to be

stronger in its effects than two commercial samples of pyrethrum. Pyrethrum seeds from Japan and Belgrade were obtained and sown in the Minor Forest Products garden. Germination was good and the plants are growing well. They started flowering after the close of the year.

The growth of *Derris elliptica* and *Derris malaccensis* was very bad; only three plants of the former were five feet in height; all the others (of both species) were less than two feet in height at the end of the year, with very few shoots and a poor root system. These two species do not like the dry heat of the summer and require protection against the winter frosts. For these reasons plantations of *Derris elliptica* and *Derris malaccensis* are not likely to be successful in northern India. They should, however, be tried in the forests of Assam and the Western Ghats where the climate is more like that of Malaya where they are grown on a commercial scale.

#### 4. MATCH WOODS.

A publication incorporating all the results of past tests was sent to the press during the year.

#### 5. COLLECTION OF INFORMATION ON DRUGS OF FOREST IMPORTANCE.

As mentioned in last year's report, this work is being carried out in conjunction with the Biochemist and the Forest Botanist. On account of certain changes made in the form of classification, etc., a good deal of additional labour was involved and the work of rearranging the information could not be finished by the end of the year.

#### 6. SUBSTITUTES FOR CORK FOR USE AS INSULATORS IN REFRIGERATORS.

Preliminary work has shown that several forest fibres and flosses could be used, especially semul (*Bombax malabaricum*) floss.

#### 7. OUTTURN OF MINOR FOREST PRODUCTS (DRUGS).

No information is at present available regarding the names and quantities of various minor forest products, especially drugs and medicinal plants, available from the forests of various provinces and states in India. As minor forest products are generally leased out for a lump sum no record is kept regarding the species collected or the quantity. A start was, therefore, made and a circular sent to all forest officers in India through the courtesy of the Inspector General of Forests and heads of Provincial Forest Departments, requesting that such information as was available might be collected from contractors and other sources. The results so far are encouraging, and replies are being received.

ed from all provinces and states. It is hoped that the good work will continue and that all forest officers, including range officers, foresters and forest guards will help to supply what information they can on the forest products available within their jurisdiction. It is only by this means that the information being collected at Dehra Dun will be made complete.

### 8. ENQUIRIES.

Over 400 enquiries dealing with the supply, collection, marketing, prices, etc., of various minor forest products were dealt with during the year.

### Paper Pulp Section.

#### 1. EXPERIMENTAL FACTORY.

(a) *Disintegration of bamboos*.—Experiments on the disintegration of bamboo were continued during the year under report. Feeding and crushing rolls were fitted to the old Norris and Christy machine. The results obtained were a decided improvement on the previous ones. It was found, however, that the rolls were too light and small to deal effectively with the whole stems of bamboos. It was also found that the flattening and partial crushing of bamboos could be effected more completely with pyramidal projections on the surface of the rolls, instead of the ribs previously used. A newly designed set of rolls, for the feeding equipment is now under preparation. With these it is hoped that it will be possible to obtain from the machine the desired results as regards the output of partially crushed chips of a size suitable for efficient digestion.

(b) Supplies of two species of bamboos, viz. : *Bambusa tulda* (mitenga) and *Teinostachyum dullooa* (dolu), which were tested in the laboratory previously, were received from Bengal towards the end of the year for semi-commercial trials. Tests were at once carried out on *Bambusa tulda* by the sulphate fractional process for determining the yields of unbleached and bleached pulps and the consumption of chemicals. Paper making trials are now in progress. The semi-commercial tests on *Teinostachyum dullooa* will be taken up shortly.

Writing, printing and wrapping papers were made from *Oxytenanthera auriculata* (kaliserri bamboo). The paper on which this report is printed is made from this bamboo.

(c) *Pulp for artificial silk*.—Experiments on the purification of bamboo pulp for use in the production of artificial silk were continued. The ouprammonium viscosities of the different samples of pulp prepared were not uniform. A study of the effect of varying the conditions of digestion and bleaching on the viscosity of pulp is now being made,

(d) The following grasses from the New Forest experimental plots were tested for their paper making qualities :—

1. *Saccharum arundinaceum* (ramsar).
2. *Saccharum munja* (munj).
3. *Saccharum spontaneum* (kans).

All the three grasses gave economic percentage yields. Clean and good quality grades of writing and printing papers and boards were also prepared from mixtures of grass and bamboo pulps.

(e) *Manufacture of paper, boards etc.*—About 3½ tons of writing, printing, type and packing papers, and mounting and drying boards were manufactured in the factory of which about 3 tons were supplied to the various offices of the Forest Research Institute and College, to the Government of India Press for the annual report and to the Silviculturist, United Provinces, for a special purpose.

## 2. LABORATORY.

(a) *Pulp for artificial silk.*—Digestions and bleaching under varying conditions, determinations of alpha cellulose, ash, copper number and cuprammonium viscosity were carried out in connection with the preparation of purified pulp for artificial silk.

(b) As desired by the Paper Mills in the conference held last year, experiments were undertaken to compare the digestibility and bleachability of chips prepared by the different systems of mechanical disintegration of bamboos in use at the various mills. *Dendrocalamus strictus* chips were supplied by the Kankinara Paper Mills, the Bengal Paper Mills and the India Paper Pulp Co. Autoclave digestions of these chips were carried out by the soda, sulphate and sulphite processes under varying conditions. Each set of experiments on the chips from the three mills was carried out under comparable conditions of digestion and bleaching. Unbleached and bleached yields and bleach consumptions were determined in each case. The experiments are still in progress. The results hitherto obtained indicate that the opening out or the partial crushing of chips helps considerably in obtaining uniformly well digested and economically bleachable pulp.

(c) *Nannel* grass, reported to be *Saccharum spontaneum*, was tested for its paper making qualities for Messrs. The Andhra Paper Mills Co., Ltd. The yield of bleached pulp was found to be low.

(d) At the request of the Tariff Board, various methods for determining the relative degree of sizing of papers were tried with a view to finding a method for differentiating between writing and printing papers in the class of cheap mechanical pulp papers imported into the country

from abroad. The method adopted by the Technical Association of the Pulp and Paper Industry, United States of America, was recommended to the Tariff Board as the most reliable.

(e) In connection with the Tariff Board inquiry into the classification of papers, determinations of the percentage of ground wood pulp in newsprint papers were also carried out by the permanganate method.

(f) *Boiler feed water.*—Routine analytical tests in connection with the softening of the boiler feed water were carried out as and when required.

### 3. TOURS AND ENQUIRIES.

(a) Mr. Bhargava visited, in October 1935, the Paper Mill at Lucknow, to give advice to the firm regarding certain matters in connection with the erection of the new grass cleaning and bleaching plant.

(b) In March 1936, Mr. Bhargava visited the Andhra Paper Mills, Rajahmundry, to advise Messrs. Dayaram & Sons, Managing Agents of the Mill, as to the necessary alterations and additions to the plant, in order to enable them to restart the mill and run it on an economic and profit earning basis.

(c) In March 1936, Mr. Bhargava also visited the Paper Mill at Titaghur to see the new bamboo pulp making plant recently installed there.

(d) Correspondence was carried on with Government departments, commercial firms and private individuals in connection with 67 technical enquiries referred to the Section.

### 4. TRAINING OF PAPER MILL CHEMISTS AND APPRENTICES.

In October-November 1935, a course of one month's lectures in theoretical and practical paper technology was given to chemists and apprentices from the Titaghur Paper Mills Co., Ltd., the Bengal Paper Mills Co., Ltd., the India Paper Pulp Co., Ltd., the Upper India Couper Paper Mills Co., Ltd., and the Deccan Paper Mills Co., Ltd. All the mills appreciated the training given to their employees as conducive to increasing their knowledge and efficiency and were of the opinion that such training courses should become a regular and permanent feature. In view of the very limited accommodation in the paper pulp laboratory and of the fact that the period of one month was not found adequate to enable the apprentices to derive the fullest benefit from the training, it is proposed to take in future only two apprentices at a time for a period of four to six months for practical training. For the benefit of the other apprentices in the various mills it is proposed to give a course of theoretical lectures in paper technology every alternate year. In this way the apprentices will be able to take full advantage of the facilities available at the Institute.

*Visits.*

The Indian Tariff Board visited the Institute in the first week of August 1935, to collect information on various points in connection with the enquiry into the classification of papers for tariff purposes.

**Mechanical Sub-Section.**

Over 500 jobs were completed during the year and a large number of other small repairs which were not booked were complied with in addition.

The Electric installation consisting of 3 D. C. Generating sets with Switch Board and Electric motors, large and small, with their switch gear, fans and lights with their wiring for the supply of current, electric ovens and other electrical tools were repaired and maintained in good order. The Iron Workshop and the machinery attached to it was maintained in good order. The 4 motor lorries, the miniature railway track and trucks, all fire appliances in the main building, workshops, laboratories and insectary were maintained in good order. The hoilers and their attachments, steam pipes and fittings and other plant attached to the workshops and laboratories were maintained in thorough good order. Amongst the more important works completed the following may be mentioned :—

The 2nd Internal Circulation Kiln in the Seasoning Section was completed and given a thorough and satisfactory trial.

A new bamboo crushing and feeding device was made and fitted to the disintegrator machine of the Paper Pulp Section. The new device has given very satisfactory results.

A new sinking apparatus was made and fitted in one of the log ponds of the sawmill for keeping logs submerged under water.

A water spraying arrangement was designed and fitted to the erosion exhibit in the Silviculturist's museum.

## CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs :—

(i) Derris species and plants likely to have insecticidal properties.

(a) *Derris elliptica*.

(b) *Derris scandens*.

(c) *Derris robusta*.

(d) *Tephrosia hamiltonii*.

(ii) *Vitex negundo*.

(iii) *Vitex peduncularis*.

B.—Oils and Fats :—

(i) *Actino-daphne hookeri*.

(ii) *Celastrus paniculata*.

(iii) *Xymenia americana*.

C.—Other products :—

(i) Kuth roots.

(ii) East African Sandal wood oil.

2. Study of forest soils.

3. Miscellaneous enquiries.

1. A.—Drugs.

(i) Derris species and plants likely to have insecticidal properties.

(a) *Derris elliptica*.—Further samples of *Derris elliptica* roots were received from Assam and analysed. In making collection of these samples attention was paid to the age and thickness of the roots, since it has been observed that both rotenone and ether soluble constituents decrease with the age and the thickness of the roots. The best time for harvesting derris is said to be when the plants are eighteen to twenty-four months old and thin roots, upto about half inch in thickness, are

generally collected for commercial purposes. The results of analysis of these samples, given below, fully substantiate the above observations :—

Species.	Locality.	Description.	Moisture in air dry	Ether extract.	rotenone.
			Per cent.	Per cent.	Per cent.
<i>Derris elliptica</i>	Dobaka Reserve, Nowgong division.	(i) Thin roots $\frac{1}{4}$ " to $\frac{1}{2}$ " Age 12-18 months.	1.7	4.53	2.41
		(ii) Thin roots $\frac{1}{2}$ " to $\frac{3}{4}$ " Age 18-24 months.	3.9	4.14	2.26
		(iii) Thick roots $\frac{3}{4}$ " to $1\frac{1}{2}$ " Age 3 years and above.	5.9	2.66	1.01
<i>Derris elliptica</i>	Kalichara, Kachar division.	(i) Thin roots $\frac{1}{4}$ " to $\frac{3}{4}$ " .	4.9	4.04	2.34
		(ii) Thick roots $\frac{3}{4}$ " to $1\frac{1}{2}$ "	1.3	3.77	1.92
<i>Derris elliptica</i>	Guma Range, Goalpara division.	(i) Thin roots upto $\frac{1}{2}$ " .	2.6	2.49	1.45
		(ii) Thick roots $\frac{1}{2}$ " to $1\frac{1}{2}$ "	4.5	1.18	0.94

The above results show that derris roots of average marketable quality, containing about 2.5 per cent. of rotenone, are available in Assam; but, in view of the low ether solubles content of these roots, they cannot be classed as good quality derris. At present derris root is valued both on the basis of rotenone and ether solubles content, since it has been found that other bodies, besides rotenone, which are extracted by ether, possess definite insecticidal properties. The trade demands a good quality derris root to contain about 5 per cent. of rotenone and about 15 per cent. of ether solubles. Therefore, to establish a trade in this important insecticide, cultivation of suitable strain will have to be resorted to, in order to improve the quality and to increase the output.

(b) *Derris scandens*.—The other species of derris examined was *Derris scandens*. The roots (moisture 5.1 per cent.) gave 2.2 per cent. of total ether solubles containing 0.26 per cent. of a crystalline substance M. P. 253°—54°. No rotenone could be isolated nor did the ether extract give the nitric acid colour test for rotenone and allied bodies. This species, therefore, does not appear to be of value as an insecticide.

(c) *Derris robusta*.—As has been reported previously, this species, although it does not contain any rotenone, contains two crystalline substances the properties and constitution of which are being studied.

(d) *Tephrosia hamiltonii*.—The air dried roots of this species containing 4.7 per cent. of moisture gave 1.2 per cent. of ether extract. The stems containing 3.0 per cent. of moisture gave 1.4 per cent. of ether

extract. No rotenone could be isolated and the ether extracts of neither the roots nor the stems gave any nitric acid colour test for rotenone. Thus none of the Indian tephrosias, examined so far, contain rotenone or allied bodies which have been found in *Tephrosia* (caracca) *virginiana* of American origin. Indian tephrosias, therefore, are not likely to prove useful as an insecticide.

(ii) *Vitex negundo*.—Further work on the constituents of the leaves of *Vitex negundo* showed that the fresh flush of leaves, collected in March, besides containing the crystalline polyhydric alcohol gluco-nonitol and the free acids p-hydroxybenzoic acid and dioxy-benzoic acid, reported last year, contains a glucoside which is sparingly soluble in cold water and comes out from hot water or dilute alcohol as a gel-like crystalline mass retaining good deal of the solvent. Purified by repeated crystallization from ether-alcohol mixture, it comes out as a faintly brown micro-crystalline powder M. P.  $154^{\circ}$ — $55^{\circ}$  C. Boiling with water alone it decomposes into p-hydroxybenzoic acid, glucose and a dark-brown amorphous substance. Hydrolysis with dilute mineral acid (2.5 per cent. solution) even at room temperature ( $20$ — $25^{\circ}$  C) decomposes it into the above products. Hydrolysing it with caustic alkali on water bath it breaks up into p-hydroxy benzoic acid and a second white crystalline glucoside M. P.  $173^{\circ}$ — $74^{\circ}$ . It can readily be crystallized from alcohol or a mixture of alcohol and ether. When this is further hydrolysed with ice cold 5 per cent.  $H_2SO_4$  for five days, it breaks up into glucose and a neutral yellow brown amorphous substance which also decomposes, either by boiling in water or by treatment with mineral acids, into the black amorphous substance. This glucoside was found to be absent in the mature leaves collected in November or December and in its place a water soluble amorphous glucoside was isolated (from the basic lead acetate precipitate) which, as was reported last year, also gave p-hydroxybenzoic acid, glucose and the dark brown amorphous substance on acid hydrolysis. The two glucosides therefore appear to be very closely related. Further work to elucidate the constitution of the glucoside is in progress. A small quantity of it has been sent to the Haffkine Institute, Bombay, for determination of its pharmacological action.

(iii) *Vitex peduncularis*.—The infusion of the leaves as well as of the root bark of this plant is reported to be efficacious in malarial and black-water fever. Nothing is known about the chemical constituents of the leaves excepting that these contain traces of an alkaloid. [Ind. Med. Gaz. (1924), 59, 133.] It was therefore thought desirable to examine once again the leaves and the root bark for their chemical constituents. Samples have been obtained from Bihar and Orissa and Assam and the chemical examination is in progress.

## 1. B.—Oils and Fats

(i) *Actinodaphne hookeri*.—In last year's report attention was drawn to the commercial possibilities of fats from the seeds of certain plants belonging to the N. O. Lauraceae, particularly *Actinodaphne hookeri*, *Litsaea sebifera* and *Litsaea lanuginosa* as important indigenous sources of lauric acid, which forms the base for sodium lauryl sulphate, a new type of detergent considered superior to ordinary soap in many respects. On account of this newly found use of lauric acid its demand is on the increase. At present commercial source of lauric acid is restricted to only a few fats such as palm kernel oil and cocoanutt oil, which however contain only about 50 per cent. of trilaurin. Hence *Actinodaphne* and *Litsaea sebifera* fats, containing about 96 per cent. of trilaurin, are a much better source of lauric acid. Even *Litsaea lanuginosa* containing 70 per cent. of trilaurin is superior to cocoanutt oil in this respect.

With a view to give more precise information regarding cost of producing lauric acid and other lauryl compounds from indigenous source *Actinodaphne* fat, which is the richest in trilaurin, was worked up on a semi-commercial scale. From 205 lbs. of the air dried berries 54 lbs. of the crude fat was obtained and this was converted into the following products :—

		Cost of production.		
		Rs. A. P.		
Crude fat (expressed)	. . . . .	35	0	0 per maund.
Purified fat (technical)	. . . . .	1	0	0 per lb.
Trilaurin (crystals)	. . . . .	1	8	0 „ „
Lauric acid (technical)	. . . . .	1	4	0 „ „
Lauric acid (crystals)	. . . . .	1	8	0 „ „
Methyl laurate	. . . . .	3	0	0 „ „
Ethyl laurate	. . . . .	1	12	0 „ „

The above figures show that the cost of production of these products is comparatively low specially the cost of lauryl esters, which are at present quoted at a much higher price on account of the low trilaurin content of the raw material used.

Samples of these products were sent to different firms, both in India and abroad, dealing with similar products and their opinion was asked for regarding their commercial possibilities and probable demand. Replies received are very encouraging and clearly indicate that there is a ready market for these products. One foreign concern expressed the opinion that they might take as much as 5 to 10 tons of trilaurin per month. It was therefore thought desirable to institute an enquiry as to how much seeds, not only of *Actinodaphne* but also of other *Litsaea* species, which too contain a fairly high proportion of trilaurin, are avail-

able in India. Accordingly, the Forest Economist has written to different Conservators of Forests in India for the required information and their replies are awaited. If trilaurin is extracted from the seeds of *Actinodaphne* and other *Litsaea* species, at present available in India, and the fat is pushed in the market and if attempts are made to augment the supply by plantation of suitable species, a valuable trade in this product can easily be developed.

(ii) *Celastrus paniculata*.—The chemical and the physical constants of this oil, said to be a sovereign remedy in Beri-beri, were reported last year. A detailed examination of the constituent acids showed that the oil is mainly composed of the glycerides of capric, palmitic, oleic and linoleic acids. No other compound, which can account for its medicinal properties, has yet been isolated.

(iii) *Xymenia americana*, Linn.—The plant grows plentifully in the coastal tracts of Tennasserim, Mysore, and Madras Presidency. The seeds are edible and are generally eaten after roasting, as then they acquire a pleasant almond like taste. The fat from the seed when freshly expressed is highly viscous and is used as a substitute for ghee. The following characteristics of the fat have been determined:—

Moisture in the kernels . . . . .	3.6 per cent.
Total oil in the kernels, by solvent extraction . . . . .	49.0 „
Colour . . . . .	Yellow-orange.
Specific gravity at 20°C . . . . .	0.9262
Refractive index at 20°C . . . . .	1.4710
Saponification value . . . . .	169.2
Iodine value (Hanus) . . . . .	82.5
Acid value . . . . .	2.3
Chemical constants of the mixed fatty acids of the fat:—	
Mean molecular weight . . . . .	319.8
Iodine value . . . . .	85.0

Further work on the isolation and identification of the constituent acids is in progress.

### 1. C. Other Products.

(i) *Kuth roots*.—It is a matter of satisfaction to note that *Kuth* (*Saussurea lappa*) grown in British Garhwal by way of experiment, has been found to be of the same quality as Kashmir 'Kuth'. Two samples of roots were received from the Divisional Forest Officer, Garhwal. One was from Bhuna nursery at an elevation of 11,000 ft. from plants four years old. It was found to contain 2.45 per cent. of essential oil (calculated on absolutely dry material). The other one was grown in a private nursery in Badrinath at an elevation of 12,000 ft. The age of the plant was about 14 years. It contained 3.86 per cent. of oil. The oil content

of Kashmir Kuth roots from plants 3 ft. or more in height has been found to vary from 2 to 4 per cent. according to age. Roots from younger plants of less than 3 ft. in height contain less than 2 per cent. of oil. A sample of Kashmir roots from plants about 5 years old has recently been examined here and was found to contain 2.61 per cent. of oil (on dry material). Thus the Garhwal samples compare very favourably with Kashmir products.

Another sample of Kuth root was received from Nepal. It was grown at an elevation of 8,500 to 11,000 ft. and the plants were 5 years old. It was found to contain 1.15 per cent. of oil (on dry material) and is thus distinctly inferior to Kashmir and Garhwal Kuth. However the above results clearly indicate the possibility of growing Kuth of average quality outside Kashmir.

(ii) *So-called East African Sandal wood oil*—In East Africa the wood of *Osyris tenuifoliata* and allied species yield an essential oil, which has an odour similar to Indian Sandal wood oil, but is fainter and more pungent. This oil is often called East African Sandal wood oil but it is altogether different in properties. It is reported to contain a sesquiterpene alcohol of the type of Santalol, the chief constituent of sandal oil, to the extent of about 30 per cent. only; whereas sandal oil contains 90—94 per cent. of Santalol. Formerly the trade in the wood and the oil was very limited, but recently large quantities of the wood and the oil distilled from it are being exported not only to China and Japan but also to India. In view of this, the Inspector General of Forests procured a sample of oil from the Tanganyika Forest Department, which was analysed with the following results:—

	B. P. specification for sandal wood oil.	Tanganyika oil.
Colour . . . . .	Pale yellow .	Very light yellow.
Odour . . . . .	Aromatic .	Aromatic, less strong slightly pungent.
Density at 20°C . . . . .	0.973 to 0.985	0.9574
Refractive index at 20°C . . . . .	1.498 to 1.508	1.4996
Angle of rotation . . . . .	—13° to —21°	—47.1°
Ester value after acetylation . . . . .	..	181.1
Calculated total Santalol content	not less than 90 per cent.	83.0 per cent.

The above results show that, although this oil does not at all conform to the B. P. Standard, it contains a much higher percentage of the Santalol like sesquiterpene alcohol than what has been recorded before for East African Sandal oil (The Volatile Oils, Guildmeister and Hoffman, 2nd ed., p. 351). In this respect it is like the West Australian Sandal oil which has been found to contain about 80 per cent. of Santalol.

## 2. Forest Soils.

Eight samples of soils were received from the Silviculturist, U. P. and were examined for their total solubles and alkalinity. Some samples of soils in connection with "manuring experiments" of the Silviculturist were examined for nitrogen, nitrates, etc. Besides these a large number of samples from the experimental plots of the Institute were also examined.

## 3. Miscellaneous enquiries.

*Acacia catechu*.—An interesting investigation, taken up at the instance of the Silviculturist, was to find out whether Burma grown *Acacia catechu* wood is generally poorer than Indian wood in total extractable matter and catechin content.

The following table gives the results of analysis of Burma grown and locally grown *Acacia catechu* wood:—

Serial No.	Description.	Diameter of billet.	Moisture.	Methyl alc. extract.	Water ext.	Catechin.
			Per cent.	Per cent.	Per cent.	Per cent.
1	Heartwood, Burma, large	2" to 3½"	3.1	13.6	13.0	1.9
2	Heartwood, Burma, small	½" to 1½"	1.5	13.2	17.3	1.7
3	Heartwood, local, small	½" to 1½"	1.4	14.0	14.0	4.3

The sample of the locally grown *Acacia* is comparable to the smaller sample from Burma, the trees being approximately of the same age. Sample from an older tree comparable with the large Burma sample was, however, not available. Even then, it is apparent from the above table that the locally grown *Acacia catechu* wood is richer in catechin content than the Burma grown wood.

Another interesting investigation, taken up at the instance of the Minor Forest Products Section, was the examination of two samples of 'katha' prepared from older trees, girth 4' to 5' and younger trees, girth 2' to 2' 6". It was stated that the katha makers of Palamau Division in Bihar and Orissa preferred younger trees for 'katha' making because there is a "deterioration in the quality of 'katha' when the *khair* tree exceeds a certain maximum age or size". The results of analysis of the two samples are as follows:—

	Katha from trees of girth 4' to 5'.	Katha from trees of girth 2' to 2½'.
	Per cent.	Per cent.
Moisture . . . . .	10.1	9.9
Ash . . . . .	5.9	7.1
Catechin . . . . .	53.8	55.5
Water solubles . . . . .	83.2	82.2

The above results clearly show that preference for younger trees is a matter of mere prejudice.

Besides the above a large number of analyses were undertaken on behalf of forest officers, officers of the Institute and other Government Departments. Of these, mention may be made of the following :—

Artemisia flower heads, Rosha grass oil, Aconite roots, samples of soap, samples of water, pine soap, copper content of pith helmet, etc.

## APPENDIX I.

*Publications of 1935-36.*

Serial No.	Title of Publication.	Author.	Date of issue.
FOREST RECORDS.			
1	A Stand Table for Sai evenaged High Forest and Coppice.	....	May 1935.
2	Illustrations of Indian Forest Plants, Part III .	R. N. Parker and C. E. Parkinson.	June 1935.
3	Immature Stages of Indian Coleoptera (16) (Scarabaeidae).	J. C. M. Gardner .	September 1935.
4	Immature Stages of Indian Coleoptera (17) (Eucnemidae).	J. C. M. Gardner .	September 1935.
5	On the Biology of Psyllidae . . . . .	R. N. Mathur .	September 1935.
6	Neue Brenthiden und Lyciden aus Indien . . .	R. Kleine .	September 1935.
7	Neue Attelabiden aus Indien (Curculionidae Col.)	Edward Voss .	October 1935.
8	Biology of Braconidae (Hymenoptera) . . .	C. F. C. Beeson & S. N. Chatterjee.	December 1935.
9	Preliminary Survey of the Forest Types of India and Burma.	H. G. Champion .	(August 1936).
10	A Study of the Soils in the Hill areas of Kulu Forest Division, Part I. An Investigation of Soil Profiles under Deodar, Spruce, Blue Pine and Chir.	E. McKenzie Taylor, I. D. Mahendru, M. L. Mehta and R. C. Hoon.	(May 1936).
11	Immature Stages of Indian Coleoptera (18) Brenthidae.	J. C. M. Gardner .	November 1935.
12	Biology of Tachinidae (Diptera) . . . . .	C. F. C. Beeson & S. N. Chatterjee.	December 1935.
13	Biology of the Ichneumonidae (Hymenoptera) .	C. F. C. Beeson & S. N. Chatterjee.	December 1935.
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		..	..	25-10-1935	31-3-1936
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			(Mr. W. A. Bailey)	12-4-1935	12-5-1935
			Mr. S. Kamesam	12-5-1935	31-3-1936
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			(Mr. A. Rehman)	15-10-1935	28-10-1935
			Dr. S. N. Kapur	28-10-1935	31-3-1936
		Paper Pulp	Mr. M. P. Bhargava.	1-4-1935	31-3-1936
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1935	1-1-1936
Entomology .	Dr. C. F. C. Beeson, Forest Entomologist.		(Capt. H. Trotter)	2-1-1936	31-3-1936
		Wood Workshop	Mr. W. Nigle	1-4-1935	31-3-1936
		..	..	1-4-1935	31-3-1936
		Systematic Entomologist.	Mr. J. C. M. Gardner.	1-4-1935	18-5-1935
			(Dr. C. F. C. Beeson.)	17-5-1936	24-10-1935
			Mr. J. C. M. Gardner.	25-10-1935	31-3-1936
Bio-Chemist .	Dr. S. Krishna	..	..	1-4-1935	1-1-1936
	(Mr. T. P. Ghose, Officer-in-charge, current duties).	..	..	2-1-1936	31-3-1936

## APPENDIX IV.

## ANNUAL FORM No. 24.

## FOREST RESEARCH INSTITUTE.

*Summary of Revenue and Expenditure during 1935-36.*

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
<b>REVENUE.</b>	<b>Rs.</b>	<b>Rs.</b>	<b>Rs.</b>	<b>Rs.</b>	<b>Rs.</b>	<b>Rs.</b>	<b>Rs.</b>
V.—Miscellaneous—							
(b) Other Sources . .	703	139	70	6	2,862	..	3,780
(d) Sale of timber and furniture from Seasoning and Wood Workshop Depot.	..	..	..	..	262	..	262
<b>Total Revenue</b>	<b>703</b>	<b>139</b>	<b>70</b>	<b>6</b>	<b>3,124</b>	<b>..</b>	<b>4,042</b>
<b>EXPENDITURE.</b>							
A.—Conservancy, Maintenance and Regeneration—							
C. 1.—Purchase of Stores, tools and plant.	133	489	817	330	2,244	51	4,064
C. 2.—Communications and Buildings, Repairs and Maintenance.	..	..	..	..	..	..	..
C. 3.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	879	1,087	4,396	2,245	2,430	395	11,422
(2) Purchase of Timber for Seasoning and Preserving (including freight and carting charges).	..	..	..	..	3,485	..	3,485
(3) Purchase of Coal, raw materials, chemicals and apparatus.	..	..	..	211	10,733	1,679	12,623
(4) Other Charges .	81	2,848	1,910	940	14,902	386	21,067
<b>Total A.—Conservancy, Maintenance and Regeneration.</b>	<b>1,084</b>	<b>4,424</b>	<b>7,122</b>	<b>3,726</b>	<b>33,794</b>	<b>2,511</b>	<b>52,661</b>

APPENDIX IV—*contd.*ANNUAL FORM NO. 24—*contd.*FOREST RESEARCH INSTITUTE—*contd.**Summary of Revenue and Expenditure during 1935-36—contd.*

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE— <i>contd.</i>							
B.—Establishments—							
I.—Pay of officers—							
Non-voted—							
(b) Superior officers	15,689	14,120	..	26,869	17,937	..	74,615
Voted—							
Superior officers	46	14,545	32,938	13,126	94,884	21,554	1,77,093
II.—Pay of Establishment.	43,873	21,170	9,225	22,035	97,540	5,147	1,98,990
III.—Allowances—							
(b) House rent and other allowances—							
Voted	523	..	..	..	..	..	523
Travelling allowances—							
(d) Superior officers—							
Non-voted	..	2,198	..	2,001	574	..	4,773
Voted							
(e) Subordinate Forest and depot establishments.	1,274	3,515	2,338	2,302	2,974	132	12,535
(f) Office Establishments.							
IV.—Contingencies—							
(a) Stationery	51	891	18	1	..	..	961
(b) Carriage of records and tents.	196	1,771	741	368	42	..	3,118
(c) Rents, rates and taxes.	6,203	107	241	..	234	..	6,785
(d) Pay of menials	..	..	..	..	..	..	..
(e) Official postage	1,294	250	206	208	540	15	2,513
(f) Sundries	11,670	731	920	1,769	1,789	578	17,457

APPENDIX IV—*concl'd.*ANNUAL FORM No. 24—*concl'd.*FOREST RESEARCH INSTITUTE—*concl'd.**Summary of Revenue Expenditure during 1935-36—concl'd.*

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
EXPENDITURE— <i>concl'd.</i>	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
B.—Establishment— <i>cont'd.</i>							
IV.—Contingencies— <i>concl'd.</i>							
(g) Clothing and uniform.	828	69	66	80	311	25	879
(h) Telephone . .	993	345	378	206	1,376	140	3,438
V.—Cost of passage granted under Superior Civil Service Rules 1924 (Non-voted).	..	1,048	..	1,200	990	..	3,238
Total B.—Establishments	82,140	60,760	47,071	70,165	2,19,191	27,591	5,06,918
GRAND TOTAL OF ALL EXPENDITURE UNDER 8.—FORESTS.	83,224	65,184	54,193	73,891	2,52,985	30,102	5,59,579
Major Head 8-A.—Share of Capital charges financed from ordinary revenue.	..	..	..	..	445	..	445
Surplus or deficit . .	—82,521	—65,045	—54,123	—73,885	—2,50,300	—30,102	—5,55,982

NOTE.—The figures given in this statement have been prepared in the President's office and are based on the Summary of Revenue and Expenditure for March 1936 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through High Commissioner on miscellaneous items.

F. CANNING,

*Officiating President,**Forest Research Institute and College.*

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**PART II.—PROVINCIAL REPORTS.**



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(This report has been printed on bamboo paper made at the Forest Research Institute, Dehra Dun.)

# FOREST RESEARCH IN INDIA, 1935-36.

## PART II.—PROVINCIAL REPORTS.

### CHAPTER I.

#### GENERAL.

**SILVICULTURE.**—Most provinces report progress in the all-India investigation of the effect of seed origin in teak. Where teak is indigenous, the local origin has usually given the best results as regards height and survival to date, though some imported origins have run them close. Nilamthur and Travancore seed have given excellent results in most centres. Research on raising mixed crops in plantations also figures in most provincial reports and much useful experience and information is being accumulated. Nearly all provinces now report good progress on the allocation of selected areas of forest as permanent Preservation Plots, though one or two have still not done much.

In Assam, an increased amount of silvicultural research has been done. In the evergreen forests it has been demonstrated that regeneration of Dipterocarps can be established in about 7 years as a result of one rain's weeding annually, *Talauma* reaching 30'-40' in this time. *Terminalia myriocarpa* seed is found to spread 400' to 500' down wind from seed trees. *Sal* natural regeneration investigations are giving promising results from rains weeding both in *Imperata* and *Pollinia* grass types.

Bengal *sal* natural regeneration experiments, on the other hand, are reported to have been disappointing. Investigations aiming at improvement of artificial regeneration work continue steadily. April stump planting with teak has given the best results and growth from stumps of *Lagerstræmia flos-reginæ* is even quicker than from seed. *Leucæna* appears to be the most suitable cover crop for use with teak, other than *Tephrosia candida*, but apparently the soil must be inoculated for satisfactory results. *T. purpurea* is found to develop into a tangled mass in the second year and so is unsuitable for use with *sal*. A search is in

progress to find a suitable substitute for *Cryptomeria* in the hills and for *gurjun* in South Bengal where the demand for this species is dull and adequate supplies of it are probably available from natural regeneration. At the same time, the number of species planted on a divisional scale is to be reduced to the few best. Methods of pruning *sal* plantations are under experiment and will be tried on other species.

In Bihar and Orissa the item most stressed is the far reaching results of experiments in irrigation of dry hill sides. Planted *Aleurites* has gone top dry after 2 or 3 years' growth and so does not appear promising. *Bombax* winter planting of stumps has been found as successful as monsoon work (as at the Forest Research Institute).

*Bombay* investigations have been mainly on sandal and teak thinning problems. Natural regeneration of sandal supplemented by dibbling in seed in poor forest infested with *Lantana* after an initial uprooting and burning of the latter has very successfully and cheaply stocked a considerable area. Early burning apparently does little harm to the tree. The teak thinning experiments have not yet given very conclusive results but the heaviest grade tried did not result in any serious amount of branching. Thinning experiments are also in progress with *Acacia arabica* in Sind.

Burma reports that teak plants raised from entire seedlings put on appreciably more height growth during their third season of growth than the comparable sets from stumps, and appear likely to catch up to the latter, though this will not deprive the stumps of the advantage of more rapid early growth and so less weeding. Covering the top of stumps planted out early was found to increase survivals considerably in areas where rainfall was not quite favourable enough for certain success. A longer root section than 8" was found to confer a small advantage in height growth not enough to cover extra trouble involved.

Natural regeneration of teak in concentrated extraction coupes comes in in any case but establishment is definitely forwarded by clear-felling the residual growth and burning. The establishment period for *Xylia* is long and this species appears not to be so tolerant of shade as it is commonly believed to be.

Useful growth statistics have become available from remeasurement of girth increment plots after 10 years of *Bombax*, *Holoptelea* and *Homalium* showing mean annual girth increment to be .63", .32" and .26" respectively, whilst a 27-year period indicates an increment of 0.35" for *Pentacme*. A trial line has demonstrated the unsuitability of the linear plot for collecting teak growth statistics in irregular forest where the stocking of this species is very low, and large compact plots of 300 acres or so will be substituted. It has been found that the basal taper of teak does not alter with age but does differ with locality.

In the *Central Provinces* experiments have shewn that clearfelling the bamboo and burning two years in succession permits of the establishment of teak regeneration where advance growth is plentiful. *Taungya* (agri-silvicultural) plantations are extending and erosion studies have been commenced in the headwaters of the Nerhudda. *Lantana* eradication measures in the Melghat where elephants are used for the purpose have resulted in grass growth sufficient to check re-invasion.

*Coorg* experiments are mainly concerned with teak and sandal. The practice of burning teak plantations at the end of their first season has been demonstrated to result therein better height growth and less weeds. Pre-monsoon stump planting of teak has given good results.

*Madras* has research work in progress on a big variety of problems and with a high standard of technique. Of special interest are the series of replicated thinning plots laid out in teak at Nilambur which should give most valuable data after a few years. Success in control measures is reported for preventing the spread of spike disease in sandal provided centres of infection are located and dealt with promptly. *Lantana* has been controlled by spraying with sodium chlorate and it has also been found that underplanted bamboo is able to push through and ultimately suppress it. Further evidence has been collected showing that in better quality teak plantations surface scraping is as effective as the more expensive forking of the soil; even in an unfavourable area, early stump planting of teak was found to be advantageous and the root length is relatively unimportant.

In dry forests, the Bombay "rab" method is rapidly extending and soil working has been found to be very beneficial to seedling regeneration. The trimming of stumps in coppice coupes is definitely harmful.

The *Punjab* reports continued experiments on strip fellings and humus removal for natural regeneration in fir forests. Artificial regeneration experiments have been made with many indigenous and exotic species in both hills and plains. In the *North-West Frontier Province*, *Ailanthus glandulosa* cuttings have been found useful for fixing land slips.

In the *United Provinces* good progress with the *sal* natural regeneration problem is reported, the chief remaining problem being to obtain to order the whippy regeneration which it is now known how to get up. (It has been done once.) The phenomenal advance in skill in artificial regeneration is noteworthy. *Baib* grass plantations can be made quite easily and yield 8-10 mds. per acre. Linear sample plots for study of growth in unevenaged forest now aggregate 41 miles in length.

**BOTANY.**—In Assam, where the duties of the Botanical Officer are combined with those of Silviculturist, botanical collections were made

in connection with the study of the ecology of the *sal* forests and the writing of the Flora of Assam.

In Burma, the post of Forest Botanist still remained unfilled ; the Silviculturist continued to remain in charge of the maintenance of the herbarium to which some collections were added and with which those interested in the flora of Burma have remained in touch. The improvement of the Botanical Garden at Maymyo, which is under the care of the Forest Department, was continued and a further contribution towards its maintenance was made by the Maymyo Municipality in view of the increasing popularity of this garden.

ENTOMOLOGY.—The investigation of the heehole borer completes its first phase with the survey of heehole incidence throughout the main teak-bearing areas in Burma ; the regeneration policy can be based on these results. Further analyses tend to reverse previous generalisations and show that natural teak may contain more heeholes per cubic foot for age than adjoining plantation trees ; even if a higher heehole incidence occurs in plantations than in natural forest the better increment of the dominant plantation trees results in relatively less economic damage. Data were obtained on parasite incidence and its probable alternate host. The parasites and predators of the teak defoliators have been extensively surveyed with the object of utilising them for biological control.

In the Central Provinces vigorous control measures on the lines now standardised were carried out successfully in a *sal* borer epidemic in Mandla and Balaghat divisions.

The research carried out by Madras on the insect fauna of sandal is recorded at length this year and its importance justifies its transference from the chapter on silviculture to that on forest entomology. Spike has been produced on sandal trees caged with spiked trees and insects ; it is believed that the vector (or vectors) is one of the Jassidae, Pentatomidae or Fulgoridae found on sandal during the day time and the night time. The seasons of infection are March-May and August-October. The polyphagous character of the chief components of the sandal insect fauna is confirmed.

UTILIZATION.—The Provincial reports contain much information of interest.

Assam has been active in starting investigations on numerous major and minor products, including a supply of 12 sample consignments of different timbers to the Gramophone Company in Calcutta for trial as gramophone cabinet woods. An attempt was also made to reorganise the cane trade which has been much upset of recent years by cut-throat competition. Plantations of *Strychnos nux-vomica* have been started

with a view to supplying seeds for the production of medicine for the treatment of cattle diseases.

In Bengal, experiments on the departmental tapping of *gurjun* oil have been started, and various timbers have been sent out for trial for a variety of uses including picker arms, hammer handles, boat-building and life-saving apparatus.

Bihar and Orissa has made a start on drawing up grading rules for hardwoods which is a useful step in the right direction. This Province also had considerable success with the exhibition held at Patna early in 1936. The Forest Research Officer was in charge of the forest display and he was able to report the award of several silver medals and certificates of merit for exhibits displayed in the forestry section. Such exhibitions undoubtedly help to bring the work of the Forest Department before the public eye and it is satisfactory to note that the United Provinces Forest department are taking steps to present a fine display at the provincial exhibition to be held at Lucknow during the coming cold weather. Bihar and Orissa is also taking steps to demonstrate the importance of proper seasoning to forest contractors and timber merchants and one seasoning shed has already been erected at Goilkera.

Burma's report is, as usual, full of interesting reading. Some of the more important activities of the year under review may be briefly summarised as follows :—

- (a) Observing the cutting of teak logs in Rangoon mills to estimate the conversion loss due to defects.
- (b) Conducting experiments in conjunction with Princes Risborough on the variation of moisture content of teak strips during transit to England.
- (c) Conducting experiments on end-coating teak logs at Kyetpyugan Depot, Insein division, with various end-coating mixtures.
- (d) Organising experiments on the seasoning and working of teak and *in-kanyin* (*Dipterocarpus* spp.).
- (e) Working up data in connection with a proposal to fix royalties on teak by means of an Index figure.
- (f) Working up data on bee-holed squares.
- (g) Studying the variation in the quality of teak timber.
- (h) Preparation of notes and articles on Burmese timbers, the match-wood industry, the variation in market price of hardwoods throughout the province, etc.
- (i) Answering miscellaneous questions on Burmese timbers, lac, catch, paper-pulp, bamboos, *tung* (*Aleurites* spp.), oil and other minor forest produce.

The Central Provinces report progress in several directions and record higher prices generally at auctions throughout the year.

Madras hopes to devote more time to the study of market conditions, the more extensive uses of wood, seasoning, wood preservation, the development of lac, the possibilities of the paper industry in the Province, propaganda and the organisation of exhibitions. For this purpose the Forest Utilization Officer has been relieved of the duty of organising the auction sales at timber depots.

The Punjab reports an experiment on the effect of sawing and launching sleepers at different times of the year and the United Provinces records some information on resin tapping.

## CHAPTER II.

## SILVICULTURE AND WORKING PLANS.

## ASSAM.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Mr. C. Purkayastha, Deputy Conservator of Forests, held the combined post of Botanical Officer and Silviculturist. Most of his time was spent on silvicultural work, inspecting the plantations and checking the plantation programmes of the Divisional Forest Officers. The plantation scheme of the Garo Hills division was prepared by him. During the year 2 experimental gardens and 6 experimental plots were started.

(ii) *Natural Regeneration.*

## A.—Evergreen Forests.

(i) *Dipterocarpus macrocarpus (hollong)—Mesua ferrea (nahor) type.*

From the experiments in the Jeypore Reserve it appears that with an open overhead canopy, advance growth of *hollong* can be established by one weeding each rains in about 7 years by which time the seedlings attain a height of 6'-7'. Of the Magnoliaceous components of the mixture, *Talauma phellocarpa* is the quickest growing, attaining a height of 30'-40' in 5-6 years.

An enumeration of the seedlings of valuable species in Experimental Plot No. 4 covering 4.1 acres shows that almost every square of 12' × 12' is stocked with seedlings of some valuable species. 64.2 per cent. of the squares is stocked with seedlings of *hollong*, the predominant species of the type. 6.9 per cent. contains valuable *sopas* (*Magnoliaceæ* except *Magnolia griffithii*), 21.4 per cent. seedlings of the other valuable species such as *Artocarpus chaplasha* (*sam*), *Amoora wallichii* (*amari*), *Cinnamomum glanduliferum* (*gunserai*), *Dysoxylum hamiltonii* (*gendheli poma*)—the first two predominating. The seedlings occur in all stages from one year old upwards. As there is no record of the initial condition of the reproduction when the experiment was started, it is difficult to say how many of the existing seedling crop have come up as a result of the treatment, but it is certain that from now onwards, if the canopy is opened out and weeds kept under control, a valuable crop can be established within a reasonable time.

(ii) *Dillenia indica* (outenga)—*Mesua ferrea* (nahor) type :—

An analysis of the figures of successive measurements of seedling heights of *nahor* in the Diroi Reserve Experimental Plot seems to confirm last year's conclusion that *nahor* seedlings grow better under a closed condition of the canopy at least in their earlier years. Definite conclusions cannot yet be drawn till the experiment has been watched for a few years more.

(iii) *Terminalia myriocarpa* (hollock) type :—

The following conclusions were reached from the experiments carried out in Sadiya division.

- (a) As far as Sadiya was concerned, the wind direction can be taken as southerly during the fruiting season, i.e., January to March.
- (b) The estimated range of seed dispersal is about 400'-500' in the open.
- (c) In Sadiya where the soil is light silt, surface wounding of soil is enough for successful regeneration of this species, but the same result may not be obtained similarly in other areas with different soil conditions.

## B.—Sal Forests.

(i) *Kamrup*.—The following from the remarks of the Inspector General of Forests summarises the whole position :—

“ The original large groups have failed chiefly due, I think, to the heavy fellings made which caused the grass to get out of control resulting in fierce fires which destroyed the original seedlings existing at the start. \*\*\*\*\* During the past three years, however, very great attention has been given locally to this question of the natural regeneration of *sal* and \*\*\*\*\* very great progress has been made chiefly from the uprooting of *Eupatorium* and rains weeding of the groups. \*\*\*\*\* There are fully regenerated groups still in the whippy state in Khokapara, Dhokin Sandubi and Modoki, many of which will certainly reach the established stage. \*\*\*\*\* In many of the plains areas not allotted to P.B.I., clearing the undergrowth, uprooting *Eupatorium* and removing rubbish in the overwood have resulted in complete reproduction which has come up under a moderate shelterwood. \*\*\*\*\* I am convinced that the present works have every promise of success and the operation \*\*\*\*\* may continue as far as this is possible.”

(ii) *Kachugaon*.—In Polo III a pure *sau* (*Pollinia*) area of 10 acres was cleared by pulling up the *sau* and burning it before seed-fall. Two weedings were carried out in the rains. Seedlings are now found in profusion and an examination of the surrounds of this area in the winter

revealed that there is sufficient recruitment on the ground, though the plants were recovered by heavy *sau* in the rainy season ; it appears possible that even weeding in the second year after recruitment has taken place may result in regeneration. Before applying this technique it has to be found out whether enough seeds can reach the soil through a mat of *sau* grass. *Sau* in the surrounding area here got burnt along with the experimental area and the regrowth of this grass was not sufficiently thick at the time of seed-fall to prevent seeds reaching the ground.

Experimental Plots laid out to study the spread of thatch in *sau* area show that, while thatch will spread in *sau* once it is there, the invasion is not always satisfactorily rapid in spite of the annual burning.

(iii) *Haltugaon*.—An experiment has been started in the Terai area with a view to determine the effect of burning and weeding in different seasons on *sal* regeneration under an open shelterwood with and without an open underwood.

(iv) *Darrang*.—The Divisional Forest Officer is experimenting with the effect of rains weeding on whippy seedlings of *sal* in the Garumari reserve.

### (iii) *Investigation on Seeds.*

#### (a) The weight of seeds and germination tests.

The results of the experiments started between 1926-28 have been tabulated. A comparison of the results of the old experiment and the works carried out in the Experimental Garden at Lowacherra shows that in the case of *Magnolia* seeds, too early collection does not give germination. Experience gained in carrying out the tests of the species of this order shows that (1), Seeds of the *Michelias* and *Talauma phellocarpa* should be collected when fully ripe, i.e., when the carpels begin to dehisce ; the pulp surrounding the seed is then dark crimson and the testa shining black ; (2), Before sowing, water test should be carried out to eliminate the bad seeds ; (3), Seeds must be coated with red lead before sowing otherwise ants will spoil them ; (4), Seeds must be sown soon after collection ; (5), Germination begins in the cold weather sometime in December but continues right up to May. *Magnolias* are the most valuable species of the mixed evergreen forests but this is the first time systematic tests have been instituted. Difference in the results of the 1926-28 experiment and that of the year under review has shown that the germination per cent. and the length of the germination period can be increased 5 to 6 times by treatment of the seeds ; this is a very important matter as the seed collection is difficult.

#### (iv) *Investigation on Seedlings.*

*Nil.*

(v) *Investigation on Trees and Crops.*

(a) *Phenological data.*—Observations are being made on 8 *sal* trees in different parts of the province.

(b) *Inheritance of individual characters.*—There are distinct growth forms of *Lagerstrœmia flos-reginæ* and experiments have been started with a view to find out whether these are hereditary characters.

(c) *Root competition.*—Investigation is in progress to study the effect of root competition of the suppressed and dominated stems on the dominant stems in the young plantations of *sal*.

(vi) *Nursery Works.*

*Dipterocarpus macrocarpus (hollong).*—This is a species of the vegetation of climax type and it is suspected that low plant per cent. (about 4 per cent.) in artificial regeneration of this species may be due to the change in soil conditions caused by burning and hoeing. An experiment has been initiated to investigate this problem.

(vii) *Artificial Regeneration.*

(a) *Dipterocarpus macrocarpus (hollong).*—The following information is gained from an experiment with artificial regeneration of this species—

Germination per cent. . . . .	12.3 per cent.
Plant per cent. . . . .	4.0 "
Maximum height attained in 8 years . . . . .	23'
Average height attained in 8 years . . . . .	18'

(b) *Amoora wallichii (amari).*—Experiments with artificial regeneration of this species show that a twig borer is the worst enemy of this species and mixture by small patches is not likely to provide a remedy from the pest of this nature.

(c) *Terminalia myriocarpa (hollock).*—Experiments are in progress in the Hakati Experimental Garden of Sadiya division, to see:—

(1) Whether cultivation of mustard as a field crop prior to the sowing of *hollock* has any detrimental effect.

(2) Whether sowing in lines 6' apart, or sowing at stakes 6'×6', or transplanting nursery raised seedlings at stakes 6'×6' has any advantage as regards cost and the quality of the stems over the divisional practice of sowing *hollock* in broad strips wide apart. Under the present system the dominant stems are always the edge trees which bend outwards.

(d) *Lagerstrœmia flos-reginæ (ajhar).*—Experiments are in progress to determine the best time for planting stumps; stumps have been put out every fortnight from Mid-February to Mid-April.

(e) *Artocarpus chaplasha* (sam).—An experiment with stump planting in Lowacherra Experimental Garden shows that use of 1-year old stumps has no advantage over direct sowing, but that using 2-year old stumps is superior to both direct sowing and to 1-year old stumps, the growth being almost double. Experiment is being repeated.

#### (viii) *Tending.*

*The sal taungyas in the Garo Hills division.*—The following tending programme has been prescribed provisionally where initial spacing is about 12' apart in lines—

1st-3rd year	2 weedings every year.
4th year	2 weedings, and a thinning aiming at the removal of suppressed and dominated stems, and spacing out of dominant plants about 3'-4' apart in the hilly areas where rat damage is not very serious.
5th year	1 weeding and thinning in the plains areas on the line suggested for hilly areas. (This operation is delayed by a year as rat damage is fairly serious up to the 4th year in the plains.)
6th year	1 weeding and climber cutting.
7th year	Climber cutting.
8th year	Undergrowth cutting and early burning.
9th year	Undergrowth cutting and early burning.
10th year	Thinning and fire protection.

*Gmelina* plantation in Sylhet division.—All *Loranthus*-attacked trees have been felled in one operation over the whole division. This has opened out the crop considerably and it will be interesting to watch *Loranthus* propagation from now onwards.

*Sal.*—The experiment in Nowgong with different spacing to study the comparative cost of raising *sal* plantations is being continued and it is expected that by the next year some figures will be available.

#### (ix) *Mixtures.*

*Artocarpus chaplasha* and *Dipterocarpus turbinatus* in intimate mixture with *Gmelina* has been started in Sylhet division on the lines suggested in the Plantation Scheme, i.e., *Gmelina* in 4 corners and either *Artocarpus chaplasha* or *Dipterocarpus turbinatus* in the centre. It is too early to record results.

Considerable difficulties are being experienced in raising most of the valuable but slow growing species such as *Alseodaphne owerdii*, *Amoora wallichii*, *Phæbe goalparensis*, etc. *Magnolias* are fast growing but due to difficulty in seed collection and germination, large areas cannot be covered by these species. The problem is further complicated by the soil deterioration that is caused in the type of the locality where they occur unless a closed canopy can be re-established in 3 or 4 years.

Experiments have been undertaken in Darrang and Sibsagar to grow them in mixture with fast growing species such as *Terminalia myriocarpa*, *Morus laevigata*, *Cedrela toona*, *Chickrassia tabularis*, etc. The proposed technique is to put 3 lines of fast growers with one line of slow growers—the idea being that thinning out of the edge lines of the fast growers will ensure proper light condition for the development of the slow growing shade bearers as well as of the central line of fast growers, and that the ultimate crop will be an intimate mixture of light demanders and shade bearers limited to two species covering not less than  $2\frac{1}{2}$  acres in any one patch. If the experiment proves successful, it may be more profitable financially than pure plantations of fast growing light demanders, which require large growing space resulting in a very small number of stems in the final crop.

The experiment will be watched with interest but till definite results have been obtained the present policy of getting a mixture by means of pure patches of small size ( $2\frac{1}{2}$ -5 acres) will be continued.

(x) *Underplanting.*

Nothing to report.

(xi) *Silvicultural Systems.*

Nil.

(xii) *Miscellaneous.*

*Preservation Plots.*—A large number of plots were selected in different parts of the province by respective Divisional Forest Officers. These have now been scrutinised. Those which did not meet the object of preservation have been rejected and fresh ones added to the list. Almost all the main types of the forests of the province are now well represented.

## BENGAL.

### I.—EXPERIMENTAL SILVICULTURE.

*Natural Regeneration of Sal.*—In Buxa division attempts to regenerate naturally areas in the Bhabar tract have not met with any great success. There is little to report in addition to what was noted last year but a survey of the position was made at the close of the year and it was considered that in the Santrabari plot, the canopy was too open, and evergreen shrubs and coppice would require to be cut back annually, together with weedings, in the rains.

In the Raimatong Bhahar, it was felt that the canopy was not open enough to allow of the replacement of *Pollinia ciliata* by *Imperata arundinacea*.

The results of the experiments in Darjeeling division at Peshoke undertaken by Darjeeling divisional staff are disappointing, and it is concluded that burning only will not induce regeneration quickly enough, if at all.

The Conservator of Forests and Silviculturist have been permitted by Government to visit Kamrup in April and September of next year, and it is hoped that this visit will show whether the methods so far adopted vary from those in operation in Kamrup, and if so whether our failure is due to this.

*Evergreen forests of Kas along, Chittagong Hill Tracts.*—It appears reasonably certain that the treatment outlined in the detailed report of last year will allow of the establishment of advance growth already on the ground: a new experimental plot was laid out to carry out these operations.

What is now required is to find out whether, and at what stage, it will be possible to carry out concentrated fellings in such areas, as the success of departmental extraction depends on intensive fellings. It is proposed therefore that a large scale Divisional Experiment should be laid out next year.

*Dipterocarpus* spp.—“Notching” of *D. turbinatus* under high shade as suggested in last year’s report was done by divisional staff in a fuel coupe. Results to date were, as expected, exceedingly good, and costs were low.

It is of importance, however, to note that while the success of this system with *D. turbinatus* is reasonably certain, there has been very little success with *D. costatus* and *D. pilosus* and experiments with these species are being continued.

Another point of policy is worthy of consideration. There are large areas of *gurjun* throughout Chittagong division for which the demand is very poor. So far attempts at restocking have mainly been with *gurjun*, and other more commercially valuable species have been rather neglected. It is interesting therefore to note that *Hopea odorata* and *Eugenia grandis* have been tried in these experiments and so far show fair promise of success.

It would perhaps be wiser to concentrate on valuable species other than *gurjuns*, and arrange for tending of the patches of valuable pole crops of *gurjun* which occur throughout the length and breadth of the Chittagong division. Experiments on the latter are being undertaken, mainly to watch the effect of cutting back miscellaneous species in *gurjun* pole areas, and also the effect of fire in reducing evergreen undergrowth.

*Nursery and Plantation work.*—Nurseries were maintained at Takdah, Sukna and Hazarikhil. Government sanction was not received to open a nursery and garden at Kuntimari in Jalpaiguri division for experiment in *khurkhani* soil.

*Takdah.*—This area is maintained by the Darjeeling division in consultation with the Silvicultural division. Its importance cannot be overestimated as it is hoped that from the numerous species now under experiment it will be possible to find something to replace *Cryptomeria japonica* as a plantation species.

Some 74 species of seed were sown during the year. The Divisional Forest Officer, Darjeeling, arranges for planting out seedlings of these exotics in his plantations.

(II) *Sukna (Kurseong division).*—This garden and nursery was maintained and routine experiments made in various indigenous and exotic species.

Of interest are *Canarium euphyllum* and *Sterculia campanulata* from the Andamans. Germination per cent. was exceedingly low in the former, but fair in the latter. Other species of interest are *Acacia lenticularis*, *Morus alba* (from Changa Manga) and *Dalbergia latifolia*.

(III) *Hazarikhil.*—Routine tests were carried out for numerous species. *Sterculia campanulata* shows promise here as also *Dipterocarpus tuberculatus* among exotics. *Xylia dolabriformis* seed was obtained and will be tested.

*Anogeissus acuminata* has done extremely well and shows promise of rapid growth.

*Stump planting.*—The teak plot, in which stumps were planted at fortnightly intervals from April to July still show that the earlier plantings are best in terms of height growth and that they grow faster than corresponding sowings or transplantings.

A disturbing feature was the appearance in this plot of canker in 40 per cent. of the stems as against only 20 per cent. in a transplanted plantation of equal sized plants. This may only be a fortuitous circumstance but merits further study.

Experiments in stump planting of other species are being continued.

In Buxa division the advantage of stump planting as far as height growth, and consequently powers of surviving suppression by weed growth, is exemplified in *Lagerstroemia flos-reginae* but a complication arises in that multiple shoots arise which presumably will have to be reduced.

*Fuel taungyas.*—These were continued in Kalimpong division with success. There is little to add to what was reported last year. It is

hoped that experiments with these and other species will eventually give information as to which species will be most suitable for fuel *taungyas*; *Casuarina* and *bracatinga* a kind of *Albizzia* from Brazil are being experimented with in the nursery.

*Artificial regeneration of sal without taungya cultivators.*—The small plots laid out at Raimatong have given rather inconclusive data, but the following facts emerge :—

- (i) *Tephrosia candida* keeps down weeds, but itself requires tending and keeping in check.
- (ii) *Imperata arundinacea* is preferable to *Pollinia ciliata* or *Anthistiria gigantea* for establishment of *sal*, but grows rank if not kept back. (It is suggested that pressing down thatch at the beginning of the growing season and probably again at the beginning of the rains is preferable to cutting.)
- (iii) *Rains weedings* are beneficial if not essential.

NOTE.—The installation of a water supply at Buxa Road will allow of *taungya* cultivation there.

*Bamboos.*—Experiments in introduction of bamboos into Baraiyadhala were continued. Mortality was 39 per cent. for *Melocanna bambusoides* and 47 per cent. for *Bambusa tulda*, partly due to an accidental fire.

Sowings in 1934 of the above, together with *Bambusa polymorpha* and *Dendrocalamus longispatus* gave poor results.

These sowings were supplemented by nursery (and in the case of *Bambusa tulda*, forest) transplants with fair success.

It is interesting to note that *Bambusa tulda* continued flowering in forests of this Range this year, and the rhizomes planted out in 1933, 1934 and 1935 in these plots have also flowered and are dying.

*Cover crops.*—Experiments continue on this subject.

*Tephrosia purpurea* has not continued to exhibit the promising appearance reported last year, as it forms a tangled mass over and between the *sal* lines and makes weeding difficult. Except in very moist areas it is leafless in the hot weather.

*Leuca crista.*—There is nothing to add to last year's report.

*Leucaena glauca.*—This species appears to be the most suitable cover crop other than *Tephrosia candida* so far but has the disadvantage of requiring inoculated soil.

*Ricinus communis.*—This was tried in the Rynkbeong range, Chittagong Hill Tracts, by the Divisional Forest Officer in a *Artocarpus chaplasha* area to keep down thatch but has not been a success as although

to begin with it was effective, it also suppressed the forest crop, and when it died after 2 years, the plants had not attained sufficient height to get above the fresh thatch invasion.

It was tried again in 1935 Sitapahar, Chittagong Hill Tracts with *gurjun* and results will be noted.

*Lagerstræmia flos-reginæ*.—The thatch-suppressing powers of this species are well known, and it is suggested, from an experiment in Rynkheong range, Chittagong Hill Tracts, that it may be made use of as a cover crop. In this particular experiment *Trewia nudiflora* and *Lagerstræmia flos-reginæ*, by alternate plants, were put into a heavy *khagra* (*Saccharum naranga*) area. Both are growing well and the floor is clean.

'Grassy blanks in sal plantations'.—The method of treatment outlined in last year's annual report is still the best method known of dealing with such areas.

It is suggested, however, that an experiment be made next year with early hurning only, i.e., not later than January 15th, with coppicing of *sal*.

*Eradication of climbers*.—From observations it would appear that hoeing up roots, while immediately more costly is preferable to cutting 6" below ground, and that annual cutting has little effect.

*Cryptomeria japonica*.—As noted last year experiments are being undertaken to try to reduce the rate of growth by closer planting. This will be costly, and it is suggested that parallel experiments should be made in planting of 3-year old plants in established plantation or coppice coupes to see whether similar results may be obtained by overhead suppression.

*Mixtures in plantations*.—There is little to add to last year's report, as it will take time to obtain conclusive results.

Generally, it is now felt that alternating groups of "lines" (strips) is the most convenient and likely method of forming permanent mixtures, but mixed line sowings in the mixtures noted last year are still in practice and are very satisfactory.

Alternate lines of *Trewia nudiflora* and *Lagerstræmia flos-reginæ* in Chittagong Hill Tracts show promise, as also "quincunx" *Bambusa tulda* seedlings (from forest) with teak. This hamhoo has also been transplanted with *Gmelina arborea* in Chittagong Hill Tracts in a 1935 plantation and results will be noted with interest in view of the excellent appearance of *Gmelina arborea* and *Melocanna bambusoides* (natural) in 1923 plantation of Rynkheong range.

*Underplanting*.—There is little to add to last year's report on this subject, and experiments continue.

*Thinnings.*—The thinning note mentioned last year is still with the press, but its principles have been followed in the course of thinnings in both silvicultural plots, and divisions.

There is still considerable difference of opinion as to whether suppressed and dominated trees should be left and removed in the course of thinnings, and also whether thinnings should be heavy or light.

In connection with thinnings in *sal*, the question of epicormic branches arose. It is a fact that much of our plantation *sal* exhibits this feature to a greater or less extent. This is not directly due to the somewhat heavier thinnings now in operation, but it is due to our failure to anticipate suppression. Thinnings let in sufficient light to allow epicormics, *already present*, to flourish. Whether this is purely temporary, and whether the ultimate quality of timber will be diminished remains to be seen. It is however a demonstrable fact in both natural forest and plantation that trees with above average crown development show clean holes, many of the trees with double leaders exhibiting this feature.

Experiments will be made in Buxa division in spacing out 3 to 4 year old *sal* to 6' spacing instead of waiting for the first thinning, under current practice, not due till after the 6th growing season. It is hoped that this "spacing thinning" will allow proper crown development and reduce the tendency to form epicormics.

*Soil samples.*—A report on these was received from Dr. J. C. Ghosh to whom our thanks are due. It appears therefrom that burning in *sal* plantations does not materially affect soil conditions, but until soil profiles have been examined, no definite conclusion can be drawn. It is hoped Dr. Ghosh will continue his investigations next year.

*Preservation Plots.*—27 plots were maintained and will be increased as opportunity occurs. Further plots are required in the Sundarhans—and also in parts of the Chittagong and Chittagong Hill Tracts districts.

*Ring countings and stem analyses.*—Stem analyses of 21 trees of 13 different species were carried out during the year. The total to date is now 182.

369 experimental plots and statistical plots were maintained during the year by the Silvicultural division.

*Special investigations.*—(1) *Pruning.*—The question of pruning in plantations was under consideration during the year, both for *sal* and other species. Plots were laid out in Buxa division in *sal* to study costs, effects and practicability of different methods of pruning:—namely, pruning flush to the bark, in comparison with pruning down to cambium, and also pruning of a certain number of selected trees within an area in comparison with pruning all trees.

It is suggested that further experimental plots be originated for other species, e.g., *Cedrela toona*, *Terminalia myriocarpa*, *Bucklandia populnea*, *Michelia excelsa*.

*Limitation of species.*—Perhaps this question is the most important of all points under consideration during the year.

During the year under review it was decided that with a view to formulating a plantation policy the Forest Utilisation Officer and Silviculturist should prepare a list of commercially valuable or potentially valuable species suitable for restocking our areas, and it was suggested that to ensure adequate supplies at maturity, not more than 4 species should be put out in any one cutting series.

This list was accordingly prepared and is now under consideration with Divisional Forest Officers. It is hoped that the question will be a *fait accompli* by the end of the rains and that thereafter there will be continuity in plantation policy.

## BIHAR AND ORISSA.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

Mr. F. C. Osmaston, I.F.S., was in charge of the Division till April 30th, 1935, when Mr. W. D. M. Warren, I.F.S., took over the Division. He held the charge for the remaining period of the year.

#### (ii) *Natural Regeneration.*

*Casuarina.*—New plots, Nos. 62 and 63 Casuarina Plantation, Puri, are to investigate whether in 9'×10' spacing, the lower branches can be layered at the time a thinning is made, if so, what should be the thinning intensity and at what age the operation should be carried out, in order to have the area completely restocked, when clear-felling is made at 12-15 years of age.

*Sal burning, Puri.*—The results of the recounts of regeneration in plots 49-57 taken after a lapse of three years show that the canopy must be opened if maximum recruitment is to be obtained, and that otherwise annual burning produces retrogression. With open canopy, annual burning with or without cutting back or hoeing encourages recruitment, and to a lesser extent so does biennial burning with or without hoeing. Progression also takes place except for biennial burning combined with hoeing when there is retrogression. Unfortunately there is no experiment to compare open canopy *plus* burning against open canopy *plus* cutting back, so that we are still left in ignorance as to whether burning is better than cutting back.

(iii) *Seeds (collection, weight, germination per cent.)*

*Teak*.—Germination per cent. varied in eight different experiments from 26 per cent. to 48 per cent. The quickest germination occurred in ten days and the slowest in 128 days. In all experiments 50 per cent. had germinated within 36 days.

(iv) *Nursery Work.*

*Nil.*

(v) *Artificial Regeneration including taungya.*

*Bombax malabaricum*.—Stumps succeed equally when planted in the cold or hot weather. It was the only species of which this could be said.

*Teak*.—Hot weather stump planting again failed in Ranchi, Angul and Kolhan except where put out after the first showers had fallen, but those put out on the 27th May 1935 in Palamau succeeded.

*Casuarina*.—Sixty-two branches buried without half slitting gave 24 branches growing well one year later or 38.7 per cent. Twenty-four half slit branches gave 15 good results or 62.5 per cent. The slit method would appear to give the best results with layering.

*Aleurites fordii*.—Two year and three year old plants are not looking very healthy. Many have become top-dry. Casualties have been greatest in the unmanured plots.

*Rosewood and Pterocarpus marsupium*.—Experience shows that rosewood and *bija* plants must be at least one year old if not two, before planting out, otherwise they are liable to be smothered by weeds.

(vi) *Reclamation and Afforestation.*

*Nil.*

(vii) *Tending—Thinnings and Cleanings.*

*Thinnings, Kolhan*.—445 acres of Sal Pole forest were thinned by the  $1\frac{1}{2}$  times diameter in inches called feet method at a cost of Rs. 1,738. The method produces very good uniform results much better than could be expected, if the thinning officer had no such rule to help him. The formula is based upon the table for Sal High forest, to be found on page 120 of the Forest Pocket Book, showing distances apart of stems for average diameters, and is within 6 inches of being correct for every diameter class except the 6" and the 8" classes where spacings in the table are greater. In intensity, the thinning is C grade, but if difficulty is experienced in selling the thinned material, dominated and suppressed trees may be left standing, in which case the thinning is a light crown one. The drawbacks to leaving dominated and suppressed stems, however, is that the full effect of the thinning is obscured.

(viii) *Mixtures.*

Nil.

(ix) *Underplanting.*

Nil.

(x) *Silvicultural System.*

Nil.

(xi) *Miscellaneous.*

*Irrigation of dry hill sal areas—Kolhan.*—Costs have now been reduced to Rs. 100 per mile by using rubble and earth bundhs and pits to check the rush of water. Twenty-one miles of trenches have now been dug. The effect of irrigation appears to be (a) to increase the humidity, (b) to lower the night temperature and probably the day temperature too and (c) to induce rain to fall under favourable conditions. *Sal* seedlings showed no signs of dying back in May and were profuse in many places. Regeneration under a close canopy has shot up from 3'-4' high to a definite under-storey 10'-12' high. Showers fell in May for an average distance of  $3\frac{1}{2}$  miles around the area, when none were recorded elsewhere in the neighbourhood. The overwood of overmature crooked unthrifty Q. IV-V trees should be clear-felled soon, once blanks are filled up, in order to enable a better crop to take their place.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

The draft Working Plans for Kolhan and Saranda divisions were submitted and have since been sanctioned. Revision of the Working Plan for the Protected Forests in Chaibassa division was undertaken and a preliminary report submitted.

(ii) *Yield, Volume and Form Factors.*

Volume and outturn statistics collection for Conversion Working Circle and Hill Working Circle Coupes was continued in Kolhan division.

## BOMBAY.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

In the absence of a separate organisation to deal with silviculture and research the Chief Conservator's office continued to control research

work of a general character. There were 10 subjects under investigation during the year. A few problems of purely local interest were taken up for investigation by the Divisional Forest Officers concerned under the general control of their Conservators.

The work done and observations made are briefly described below :—

### (ii) *Natural Regeneration.*

Sandal (*Santalum album*).—*Subject No. 28.*—Effect of early burning on sandalwood growth and regeneration. (Division :—Belgaum.)

The 2nd remeasurements of the 100 sandal trees in each of the plots 28A and 28B were taken in December 1935. The trees were reclassified into 1" girth and 3' height classes with the following results :—

	Plot A. (Protected.)	Plot B. (Early burnt.)
Average girth at—		
Original measurement . . . .	4.97"	5.59"
1st remeasurement . . . .	5.60"	5.65"
2nd remeasurement . . . .	5.63"	5.65"
Average height at—		
Original measurement . . . .	12.12'	12.27'
1st remeasurement . . . .	12.66'	12.84'
2nd remeasurement . . . .	12.72'	12.87'

There is no significant difference in the average girth and height development between the plots and this confirms the result obtained in the original experiment.

The Silviculturist, Dehra Dun, suggested that these trees should be kept under observation for 3 years. One more remeasurement therefore remains to be taken for the completion of this experiment.

### (v) *Artificial Regeneration.*

*Hirda (Terminalia chebula).*—*Subject No. 37.*—Sowing and planting of *hirda* on laterite soil in the shade of existing shrubs or small trees. (Divisions—Poona and Satara.)

In the Vadgaon range of the Poona division 2 plots have been formed. In one plot *hirda* seed was sown in 100 pits, 3 seeds in each pit, and in the other 100 stumps were planted in the shade of existing shrubs or small trees. 111 seedlings resulted from the sowing, and 96 stumps gave shoots. Weedings were carried out in August and December 1935, earthing up was done in December 1935 and watering from February 1936. The survivals in February 1936 were 60 seedlings and 66 transplants.

This experiment could not be replicated in the Satara division for want of seedlings for stump planting. The seedlings have been raised in a nursery but the Divisional Forest Officer is of opinion that under the conditions prevailing at Mahableshwar stumps from 2-year old seedlings are necessary for obtaining satisfactory results.

**Teak** (*Tectona grandis*).—The felling and burning of a small area of evergreen forest at Helwak in the Satara division was done and on the site teak seed was sown. The results were very good and the seedlings which are strong and healthy show exceptional growth for this division.

**Sandal** (*Santalum album*) (Belgaum division).—The sandalwood regeneration work mentioned in the last year's report was continued during the year with the most encouraging results. The whole area of 30 acres was again gone over and all blanks planted up and casualties replaced by fresh dihhles. The *Lantana* which was cut back and burnt in 1934 threw out new sprouts which provided excellent protection for the new plants. Altogether there are some 6,300 one-year old plants and 3,000 2-year old plants in the area. The stocking is said to be excellent—as a most valuable plantation has been raised at practically no cost on what was a worthless bit of jungle infested with *Lantana*.

#### MISCELLANEOUS SPECIES.

(Larkana division—Sind.)

Experimental sowings of *tali* (*Dalbergia sissoo*) and mulberry seeds obtained from the Punjab were carried out in the Bahaman forest. Germination was on the whole excellent, being over 80 per cent. The seedlings are healthy and vigorous, though the rate of growth does not appear to be as good as that in the older plantations presumably on account of the soil being sandy.

Seeds of *Acacia catechu* and *Bombax malabaricum* were sown in two plots, each quarter of an acre in extent. Germination was profuse. Excess seedlings were used for transplanting in order to ascertain whether these species could bear transplanting in Sind. The transplants have survived and are considered to be established.

Bamboo seed, received from Kanara, was sown in specially prepared nursery beds. Germination was very satisfactory but unfortunately all the seedlings were uprooted by pigs. It is worth noting that no damage was done to *khair* seedlings growing nearby.

Experimental sowings of *tali* (*Dalbergia sissoo*), mulberry, *khair* (*Acacia catechu*) and *Bombax* were also done in the Kasimshah forests but the results were very poor due to several adverse factors.

The Divisional Forest Officer remarks that *khair* germinated well even in slightly saline soil and that it can stand ordinary Sind cold and of all the Presidency species appears to be most suited for introduction in Sind. *Bombax* can grow only in soil free from *kalar* and is susceptible to even ordinary cold.

(vii) *Tending—Thinnings and Cleanings.*

*Teak.—Subject No. 4.*—Effect of thinnings on teak coppice at different ages. (East Thana division).

The second remeasurements in plots 4B2, 4, 6 and 8 were taken and recorded during the year.

The object of this experiment is to find out not only the effect of thinnings but also the relative value of retaining 1, 2 and 3 shoots on a stool. The Divisional Forest Officer has not dealt with the subsidiary aspect of the investigation in his report. The original registers obtained from him are incomplete and do not give the required information. The necessary computations will be made in this office, for the purpose of analysing the results from the two remeasurements recorded so far, and a further summary will issue later on.

*Subject No. 5.*—Effect of different degrees of thinnings in teak plantations of different ages. (Divisions—West Nasik and West Thana.)

The sample plots in the West Thana and West Nasik divisions have been abandoned.

*Subject No. 34.*—Effect of different degrees of thinnings in teak plantations. (Divisions—Kanara N. D., E. D., and W. D.).

For the purpose of this investigation 4 plots, ranging from 11 to 14 years of age each divided into 4 sub-plots and thinned to A, B and C degrees, are under observation in the three Kanara divisions. The first remeasurement in these plots was taken in 1935-36, i.e., 5 years after the date of the original measurement. The following are the mean diameters arrived at :—

Sub-plot No.	Treatment.	MEAN DIAMETER.		
		At original measurement.	At 1st remeasurement.	Difference.
	<i>Plot No. 34-D—11 years.</i>	Inches.	Inches.	Inches.
I	Control . . . .	3.6	4.9	1.3
II	" A " degree . . . .	3.5	5.1	1.6
III	" B " " . . . .	3.1	4.7	1.6
IV	" C " " . . . .	3.5	5.9	2.4
	<i>Plot No. 34-B—12 years.</i>			
I	Control . . . .	3.2	4.0	0.8
II	" A " degree . . . .	3.9	5.5	1.6
III	" B " " . . . .	3.5	5.3	1.8
IV	" C " " . . . .	3.7	5.6	1.9

Sub-plot No.	Treatment.	MEAN DIAMETER.		
		At original measurement.	At 1st remeasurement.	Difference.
	<i>Plot No. 34-C—13 years.</i>	Inches.	Inches.	Inches.
I	Control . . . .	3.3	3.9	0.6
II	"A" degree . . . .	3.6	4.3	0.7
III	"B" " . . . .	3.8	4.8	1.0
IV	"C" " . . . .	3.8	4.7	0.9
	<i>Plot No. 34-A—14 years.</i>			
I	Control . . . .	3.8	3.9	0.1
II	"A" degree . . . .	3.7	4.2	0.5
III	"B" " . . . .	4.1	4.7	0.6
IV	"C" " . . . .	4.1	4.4	0.4

The above figures show that the rate of diameter increment is highest in the 11-year old plot, the 12-year old plot showing slightly less while in 13- and 14-year old plots the increment is much less.

As regards the effect of different intensity of thinnings on the diameter increments, the figures are rather conflicting. In plots D and B the progress is in the order expected, *i.e.*, IV, III, II but in plots C and A the order is III, IV, II and III, II, IV respectively. The sub-plot I (control) in all the plots have shown the lowest increment. The general mean diameters, however, indicate the expected order, *i.e.*, IV, III, II, I as given below:—

		Sub-Plots.			
		I.	II.	III.	IV.
		Inches.	Inches.	Inches.	Inches.
Plot D . . . .		1.3	1.6	1.6	2.4
Plot B . . . .		0.8	1.6	1.8	1.9
Plot C . . . .		0.6	0.7	1.0	0.9
Plot A . . . .		0.1	0.5	0.6	0.4
TOTAL .		2.8	4.4	5.0	5.6
General mean . . . .		0.7	1.1	1.25	1.4

The mean height increments of plots D, B, C and A are 7.75, 12.0, 2.5 and 2.5 feet respectively.

The Divisional Forest Officer, Working Plans, S. C., has made the following remarks :—

- “(1) Heavy thinnings have not resulted in the development of epicormic branches or strong side branches likely to reduce the value of the bole.
- (2) Only in one instance, namely, Gersoppa 34 C did heavy thinnings result in some wind-falls. Here 8 trees in the sub-plot IV and some trees of the surround as well were broken by wind in the year following the thinning operations.
- (3) The canopy in all the plots was found to have closed up except in the case of original gaps which had existed from the date of formation.
- (4) In sub-plots I, II and III there is very little undergrowth in the well-stocked portions. Thinning in sub-plot IV has resulted in the maintenance of undergrowth throughout the plot.”

As regards suggestions for the future it is necessary to take careful note of the period required for the canopy to close up after thinning according to each grade and to prescribe the interval of thinnings for each degree of intensity.

As the original gaps are likely to take at least another five years to close up, the next interval of all thinnings may be fixed at about 5 years and when carrying out the next thinnings the varying degrees should be so fixed as to provide a different interval for each grade.

*Subject No. 8.*—Increment of *babul* (*Acacia arabica*) under different degrees of thinnings. (Division :—Hyderabad-Sind.)

No field work was done in connection with the old set of 10 plots worked according to the Dehra Dun Method (A, B and C grades) as the thinnings in these are not due till November 1936.

As regards the additional set of 9 one-acre (and not half acre as stated through oversight in last year's report) plots laid out in March 1934 in compartments 9 and 10, Manjhand forests, and in which a preliminary 10'—20' (sapling) thinning was carried out during May 1934, six were thinned a second time during January last as under :—

One set of 3 plots (Nos. 13, 16 and 19) to 20'—40' spacing (mean 30 feet) called the “Heavy Thinning” and the other set of 3 plots (Nos. 12, 15 and 18) to 15'—30' spacing (mean 22½ feet) named the “Moderate Thinning”. It was not considered advisable to open up these areas suddenly, so a period of 1½ years was allowed to elapse between the first and second thinning.

The remaining set of 3 plots (Nos. 11, 14 and 17) already thinned at 10'—20' spacing called the "Light Thinning" had not to be treated this year.

The measurements as laid down in the Statistical Code have been recorded for the six plots thinned during the current year and the complete record together with the previous one is being forwarded to Dehra Dun for computation.

(xi) *Miscellaneous.*

*Sandal.*—*Subject No. 7.*—Annual Girth increment of sandal. (Divisions :—Belgaum and Dharwar-Bijapur.)

The triennial measurement of girth in plots 7A I to IV was carried out in May 1934 and in plots 7B I and II in November 1935.

The average girth increment per tree per annum as shown by the measurement is as follows :—

Plot 7-A—									
I	.	.	.	.	.	.	.	.	·15"
II	.	.	.	.	.	.	.	.	·14"
III	.	.	.	.	.	.	.	.	·21"
IV	.	.	.	.	.	.	.	.	·14"
Plot 7-B—									
I	.	.	.	.	.	.	.	.	·24"
II	.	.	.	.	.	.	.	.	·27"
TOTAL									1·15"
Mean annual increment									·19"

NOTE.—Only those trees registering an increase in girth have been taken into account in arriving at the increment figures.

*Subject No. 32.*—Correlation existing between the outer girth increment and heartwood increment of sandal. (Division :—Dharwar-Bijapur.)

Borings in this plot which remained incomplete last year were completed during the year and the data recorded show that in 50 per cent. of the trees there is a decline in heartwood development. The next measurement is due in 1938-39.

*Bahan (Populus euphratica).*—*Subject No. 10.*—Economic age for *bahan*—vitality of coppice stools. (Division :—Shikarpur-Sind).

Plot 10D was felled in the 2nd rotation and necessary data recorded. The yield in the form of poles has been very low in all classes, the out-turn being 205 poles as against 660 in the first rotation.

The Divisional Forest Officer remarks that there appears to be a general lowering of vitality of the stems in this plot for which no particular reason can be assigned. He also states that the set of the river is against the forest and that a part of sample plot No. 10B which was worked in 1933-34 has been washed away.

Plot No. 10A is due for felling in its 3rd rotation and 10B in its 2nd rotation in the year 1936-37.

*Miscellaneous species.*—*Subject No. 16.*—Effect of improvement fellings on diameter growth (Dangs, Surat) (Teak and important jungle-woods).

There is nothing to record this year. Next measurements are due in December 1936.

*Temburni (Diospyros melanoxylon).*—*Temburni* trees were pollarded in the month of November in five different localities in Kanara, N. D., and it was found that the leaves of the pollarded trees were on the whole larger and more flexible than those of unpollarded trees. The yield from pollarded trees was, however, only about 50 per cent. of that from unpollarded trees.

*Tung trees (Aleurites fordii).*—In N. D. Kanara a small quantity of *Aleurites fordii* seed was sown in a teak pole coupe and a High Forest regeneration coupe in the Sambrani range on the 26th and 27th June 1935. The seed had obviously deteriorated since out of 20 seeds sown in the teak pole coupe only three germinated and out of the same number sown in the High Forest coupe only one seedling was obtained. In the High Forest area with its heavier rainfall, the seed germinated in 4 weeks whereas in the teak-pole area two seeds germinated in about 6 weeks and one after 2 months and 5 days. All the seed was sown on burnt soil in prepared pits half of which were further enriched by the addition of farmyard manure and wood ash. There was no material difference in the rate of growth of manured and unmanured seedlings. All the plants have survived the hot season.

*Lac.*—The experiment in the propagation of lac on *palas (Butea frondosa)* trees at Mandihal in the Dharwar range of the Dharwar-Bijapur division was continued during the year. About 15 lbs. of seed lac was collected.

*Phenological observations.*—Under instructions from the Silviculturist, Forest Research Institute, Dehra Dun, phenological observations on teak have been undertaken in North Thana, Panch Mahals, North, East and West Khandesh and Kanara Northern divisions.

## II.—WORKING PLANS.

The revised working plan for the Thana forests was sanctioned by Government during the year.

## BURMA.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) General.

*Staff.*—Mr. R. W. V. Palmer, Deputy Conservator of Forests, was in charge of the division up to 17th April 1935 from which date to the end of the year the charge was held by Mr. C. W. D. Kermode, Deputy Conservator of Forests.

(ii) *Programme of Work.*

During the year a new five-year programme of work was drawn up by a committee consisting of the Conservator of Forests, Northern Circle, the Conservator of Forests, Working Plans Circle, and the Silviculturist. After some slight alterations and additions it was accepted by the Chief Conservator of Forests, Burma.

(iii) *Nursery Experiments.*

A continuation of the experiments carried out in 1934 was made at two centres—Sintesan in Insein division and Kunsan in Zigon division. Last year's annual report stated that the most consistent results were obtained by alternate soaking and drying of the seed. The method employed in the 1934 experiments was soaking for twelve hours and spreading out to dry for forty-eight hours. The differences obtained were small and it was considered that the treatment was probably stopped too early (12½ days' duration only). In the year now under report two treatments were tried, alternate soaking and drying as mentioned above but the process repeated eight times making a total of 20 days' treatment and the ordinary divisional method. Seeds from each treatment were sown under two conditions—(i) unworked nursery beds and (ii) worked nursery beds. At each centre four nurseries were laid out on low ground and four on high ground. Each nursery consisted of sixteen beds. One hundred seeds were sown in each bed. Results are given below :—

In each case "A" and "C" are treated seed on unworked and worked beds respectively. "B" and "D" are divisional method controls on unworked and worked beds.

*Kunsan, Zigon division.*—The divisional method consists of piling the seed in small heaps and leaving them exposed to the weather. When signs of germination appear the seed is broadcast in nurseries.

On flat ground the results show that the treated seeds on worked and unworked beds are significantly better than the divisional methods on either throughout the course of the experiment. There is no significant difference with treated seeds on worked and unworked beds. On high ground treated seeds show the same result as above except that treated seeds are significantly better on worked beds than on unworked beds.

*Sintesan, Insein division.*—The divisional method is the same as that employed at Kunsan in Zigon division.

In the case of nurseries on flat ground, in the early stages the treated seed was the better, the results on both worked and unworked beds being significantly better than the divisional method on unworked

ground. The treated seed on worked ground only was significantly better than the divisional method on worked ground. Later in the experiment there was no significant difference anywhere.

On high ground the results were more variable. At the beginning treated seeds on worked beds were the best ; later on there was no significant difference between the treated and untreated seeds on worked beds. Early in the experiment treated seeds on unworked beds gave significantly better germination than the divisional method on worked or unworked beds. Later the divisional method on worked beds became significantly better than treated seeds on unworked beds. From the above it will be seen that the two centres differ markedly.

### (iii) Experiments with Teak Stumps.

During the year the plots laid down in 1933, an account of the last remeasurement of which is given in last year's report, were remeasured. The results are tabulated below. No further remeasurements of these plots will be made as the trees have reached such a height as to render accurate measurement impracticable. All heights are in feet and one place of decimal :—

Centre.	Details.	Date planted.	No. of stems.	Mean height	Mean height	Mean height	Percentage of	Percentage of
				survivals to end of 1st rains.	survivals to end of 2nd rains.	survivals to end of 3rd rains.	survivals to end of 2nd rains.	survivals to end of 3rd rains.
Sintasan (Insein), Rainfall 96".	Stumps. Break of rains.	24th May 1933.	246	3.3	9.6	15.2	98	98
	Late stumps . . .	13th June 1933.	246	1.4	6.3	12.9	85	88
	Transplants (Divisional method).	9th June 1933.	246	1.4	6.6	13.1	96	92
Nyaungbin din (Tharawaddy), Rainfall 81".	Stumps. Break of rains.	27th May 1933.	240	2.0	8.7	13.1	99	98
	Late stumps . . .	15th June 1933.	240	0.7	5.3	10.7	85	84
	Transplants (Divisional method).	11th June 1933.	240	0.9	5.6	10.6	93	91
Kunshan (Zigon), Rainfall 81".	Stumps. Break of rains.	26th May 1933.	290	3.3	12.3	15.2	96	96
	Late stumps . . .	13th June 1933.	280	0.9	7.1	10.2	75	73
	Transplants (Divisional method).	14th June 1935.	376	1.0	7.5	11.2	96	95
Myohla (North Toungoo), Rainfall 56".	Stumps. End of May.	30th May 1933.	299	2.0	5.9	8.8	87	58
	Late stumps . . .	13th June 1933.	291	1.4	4.3	7.9	66	55
	Direct sowing (Divisional method).	22nd April 1933.	198	0.8	2.8	5.9	59	47

There were very few casualties in the third year except at Myohla where landslides were responsible for a fair number.

The original advantage of planting stumps at the break of rains is now showing a tendency to become lost. In the table given below figures show that in the first and second year stump plants grow faster than seedlings; in the third year the position is reversed and at every centre seedlings put on more growth than stumps. In no case, however, have seedlings yet reached the same total height as stump plants but the figures would tend to indicate that in a few years' time there will be no difference in the total heights. The extra growth put on by the stumps in the first two years is of importance as the cost of weeding will be lowered. It would appear that no further advantages will accrue from this method.

Centre.	Method.	GROWTH PUT ON IN			Total height.
		1st year.	2nd year.	3rd year.	
Sintesakan . . .	Stumps . . .	3.3	6.3	5.6	15.2
	Transplants . . .	1.4	5.2	6.5	13.1
Nyaungbinsin . . .	Stumps . . .	2.0	6.7	4.4	13.1
	Transplants . . .	0.9	4.7	5.0	10.6
Kunsan . . .	Stumps . . .	3.3	9.0	2.9	15.2
	Transplants . . .	1.0	6.5	3.7	11.2
Myohla . . .	Stumps . . .	2.0	3.9	2.9	8.8
	Transplants . . .	0.8	2.0	3.1	5.9

Experiments were continued in 1935 rains in six centres. The scope of the experiments is given below :—

- (1) Experiments in early planting of stumps.
- (2) Experiments in planting at the break of rains and at 7, 14 and 21 days later.
- (3) A root length experiment.
- (4) A patching experiment.
- (5) An experiment with coppicing.

No. (1). In this experiment one lot of stumps was planted at the end of April (except B wet), a second lot in May and a third lot at the break of rains.

The results of this and previous year's experiments would apparently indicate that the higher the rainfall of the centre the better chance there is of getting good results from early planting. To take the two extremes Ataran (rainfall about 200") and Promé (rainfall about 50"), in the former case early planting of stumps even without protection has succeeded every time while in the latter early planting even though it has been done as late as the middle of May and the stumps given some protection has proved a complete failure. Sintesakan with a high rainfall has been successful and Zigon very similar to Promé has been a failure. Before this method is adopted by any division it would be well to try it out on an experimental scale for some years as difference in time of the break of rains might effect the survival of the stumps.

No. (2). At three centres, Sintesakan, Kunsan and Kaing, experiments were made with planting stumps at rains break and later. In the Sintesakan centre stumps made from two-year old seedlings were used. There appears to be no advantage in doing this as comparison of the mean height survivals of this goes to show. Also in practice it is inconvenient as two-year old seedlings are apt to be from 4-6 feet high with a corresponding root system and the labour of digging up and preparing them is considerably greater than in doing this for one-year seedlings.

No. (5). A coppicing experiment was carried out at two centres. One-year old seedlings and one-year old stump plants were coppiced and the growth of the coppice shoots as compared with the growth of uncoppiced stems is shown below. Heights are in feet and one place of decimal:—

Centre.	Details.	No. of units used.	Average initial height.	MEASUREMENT DURING 1936 HOT WEATHER.		
				Mean height.	Casualties.	Mean height survivals.
Sintesakan	Seedlings. Coppiced .	260	0.8	3.5	11	3.7
	Seedlings. Control .	260	0.9	4.1	31	4.7
Kunsan	Seedlings. Coppiced .	70	1.0	4.8	6	5.2
	Seedlings. Control .	68	1.1	7.0	0	7.0
	Stumps. Coppiced .	102	1.6	6.0	9	6.5
	Stumps. Control .	94	2.4	9.1	3	9.4

(v) *Underplanting of Teak.*

In 1934 a number of plots were laid down to ascertain whether *Dalbergia latifolia* could be introduced under teak after thinning and to

see whether its introduction had any significant effect on the subsequent height and diameter growth of the crop. This species was tried as a result of some notes by the Central Silviculturist on page 463 of the *Indian Forester* for July 1933. It is too early yet to see what the effect on the teak will be.

(vi) *The Establishment of Natural Regeneration of Teak and Pyinkado on an area where Concentrated Extraction had been carried out.*

Experimental plots Nos. 1 to 5, Yonbin reserve, Pynmana division.

In the case of teak there has been a big increase in the number of seedlings in three plots. This is no doubt due to the presence of seed-bearers near these three. Regeneration comes in whether the cover is removed or not or whether it is burnt or not. The removal of the cover apparently has a very definite effect on the establishment of regeneration as the growth in plot No. 1 indicates.

With *pyinkado* there has been no increase in the final amount of regeneration though there have been temporary increases between 1930 and 1935, and the results would appear to indicate that fire-protection is beneficial to the establishment of regeneration although the results are not at all conclusive as a higher percentage has reached a height of 15' and over in plot 1 which was burnt than in plot 5 which was protected.

*Investigation of the Influence of Seed Origin in the case of Teak.*

This is an all-India experiment in which Burma is collaborating. Previous references have been made to it in the annual reports for 1931-32, 1932-33, 1933-34, and 1934-35.

Further experiments were laid down at Kunsan (Zigon) during the year. Seeds of six origins were used; Zigon, Mysore, Travancore, Khandesh, Nilambur and Myitkyina.

Half-acre plots were planted of Zigon, Nilambur, and Travancore seed, and quarter-acre plots of Mysore and Khandesh, there not being enough seedlings for larger plots of the two latter. Germination of Myitkyina seed was so poor that no plot was made. In addition rows of one hundred seedlings of each origin were planted.

Combined average results for all plots at this centre up to 5 years of age are as follows :—

Origin.	AVERAGE HEIGHT SURVIVALS IN FEET AND DECIMALS TO AGE OF				
	1 year.	2 years.	3 years.	4 years.	5 years.
Nilambur . . . .	1.2	7.8	12.0	19.9	20.1
Travancore . . . .	1.4	7.5	13.0	17.3	19.4
Zigon (local) . . . .	1.0	6.5	12.1	19.1	22.2
Kanara . . . . .	1.3	7.3	9.8	14.6	17.6
Myitkyina . . . . .	1.3	7.0	10.9	13.8	16.1
Mysore . . . . .	0.9	7.1	10.4	..	..

## CENTRAL PROVINCES.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

1. Before giving a more detailed summary of the individual problems in different divisions and of the methods in which these problems are being investigated, it will be useful to give a brief summary of the general lines on which forest management has developed in the Central Provinces during the last ten years, as this will indicate how the problems have arisen.

2. With the exception of the *sal* forests in the eastern divisions, which are not of great financial importance, teak is by far the most important species in most of the forests of the Central Provinces, although the proportion of teak in the growing stock varies very widely. The average quality is probably everywhere IVa (height growth 40 to 50 feet), but improves to III quality or even to II quality over comparatively small areas.

3. Until ten years ago these forests had nowhere been worked under any system except conservative improvement fellings; in many places a complete cycle of such fellings had passed over the forests and had resulted in the removal of a large quantity of over-mature and badly grown old stock. It was at length realised that such fellings could be no more than a temporary phase in the treatment of teak, a tree which is an extreme light-demander, and in forests where the main demand is for small timber, poles and fuel.

4. During the last ten years working plans based on detailed stock mapping have been prepared for almost all the teak forests, and in nearly every plan conversion to even-aged forest has been prescribed: the conversion rotation varies from about 40 years in the poorer and more common types of forest to 100 years in the best quality forests, but the principle is everywhere the same, namely, that teak must be grown under an even-aged system. It has been pointed out that teak forests cover a large proportion of the total forest area, and such a radical change in system over wide areas in such a short period has inevitably given rise to numerous problems which have not yet been solved and over some of which a somewhat heated controversy is still raging.

5. When conversion was first prescribed, somewhat different methods of treatment were envisaged in the poorer and in the better quality forests; in the former, conversion was to take the form of a simple coppice system, while in the latter it was suggested that a procedure more closely approximating to the European uniform system would be appropriate. It was, however, quickly realised that the difference between the two classes was one of quality rather than of silvicultural type, and it has also been found that while teak reproduction is abundant over very wide areas, its presence depends upon the condition of the underwood rather than of the overwood, and that where it is absent, it is not to be obtained by any manipulation of the canopy.

6. The conditions in the underwood which appear most inimical to teak regeneration are a rank growth of grass or a dense understorey of hamboos or of scrambling shrubs. The most valuable teak forests, such as the forests of the South Chanda division and of Bori in Hoshangabad division, are subject to little or no grazing hut aound in hamboos or other undergrowth, and it is in these forests that conversion operations have so far been least successful. In most of the poorer teak forests, which are usually heavily grazed, teak reproduction is generally so abundant that the results of clear felling have been successful beyond anything hoped for when the system was introduced. It was at first assumed that conditions in the more remote and better quality forests would certainly not be less favourable, and these were therefore similarly treated.

7. The result has been that in the better hut more remote forests, conversion has been only a limited success: in South Chanda artificial regeneration has been resorted to, in Bori there is considerable apprehension regarding progress, and in North Chanda it has been necessary prematurely to revise the working plan in order to curtail conversion operations in hamboo forests, and to make special provision for the felling of the hamboos several years in advance of the main fellings in the hopes of stimulating the reproduction of teak. At the same time it

must be pointed out that these are exceptional cases and that conversion operations have generally been satisfactory.

8. Another danger which was perhaps insufficiently appreciated is frost: a period of several years of immunity had led to an assumption that this was only a remote danger and to be feared only in the most unfavourable localities. For several years the reproduction had made excellent progress, when suddenly a heavy frost supervened, and in a single night vast areas of young teak in the northern divisions were cut back to ground level or seriously damaged. It is now therefore clear that the method to be adopted in converting frost liable forests is one of our major silvicultural problems.

9. Another matter which has given rise to much controversy and in which the forest officers of the province are gradually ranging themselves in opposing camps is the question of what trees should be reserved to form part of the future crop when conversion operations are undertaken. In our earlier conversion plans, clear felling was generally prescribed in areas where there was adequate advance growth. A conservative or reservationist school then began to contend that such clear fellings involved the needless sacrifice of much immature young stock; for instance, *semal* (*Bombax malabaricum*) and *bija* (*Pterocarpus marsupium*) are usually saleable only in large sizes, while the price increment of teak over two feet in girth is very rapid, and it was argued that even though teak poles might be saleable, it was financially desirable to retain them to attain a more profitable size. The members of the radical school, on the other hand, who are known locally as the advocates of *hajamat*, might occasionally permit the retention of groups of such poles, but would point out that poles retained singly would be very liable to windfall and that any reservations were of very doubtful advantage in the case of the light demanding teak as they would be likely to suppress the advance growth. Another contention of the reservationist party has been that clear fellings in a forest with a fair proportion of teak have often led to its conversion to pure teak forest, as teak coppice grows quicker than anything else and is less subject to the browsing of deer; some plans have therefore prescribed the reservation of pole of miscellaneous species in order to preserve the mixture. The clear felling school, on the other hand, have argued that conversion to pure teak is an inevitable natural process, and that to attempt to delay it by retaining a few scattered poles of other species is as futile as trying to sweep back the tide with a broomstick.

10. It will thus be seen that the major problems which have to be solved in the treatment of our teak forests are the following:—

- a) How to obtain established teak reproduction in forests with a heavy undergrowth of grass, bamboos or shrubs.

- (b) How to regenerate teak forests liable to occasional frost.
- (c) To what extent should trees be retained in conversion operations, either to avoid financial sacrifice or to prevent the formation of excessively pure teak crops.

11. These are all matters on which there is still much difference of opinion and which will continue to require investigation for many years. The details of these problems in different divisions and the experiments that have been started to solve them are dealt with in the following paragraphs.

### (ii) *Natural Regeneration.*

12. The following is a summary of interesting observations in divisional reports :—

*Nimar.*—Wherever grazing is not excessive teak reproduction is generally satisfactory if the soil is suitable and drainage good. In many places teak is rapidly spreading into mixed forests except in places where the ground is hardened by excessive trampling, in open areas, frost holes and forests with rank grass. The reproduction of other species is generally fair but that of *salai* (*Boswellia serrata*) is scanty : trees of this species below two feet girth are uncommon and it obviously ceased to reproduce itself some years ago for no apparent reason.

The coppice reproduction of teak is usually excellent both in the simple coppice and high forest working circles, except in localities where it suffered from the severe frosts of 1934 and 1935 and had to be cut back. The coppice of other species is generally satisfactory but suffers severely from the browsing of wild animals. *Chital* are so destructive in certain felling series that steps are being taken to reduce their number. *Salai* (*Boswellia serrata*) usually coppices well but in certain localities it has failed to coppice.

13. *South Chanda.*—The natural reproduction of teak is reported to be satisfactory except in the neighbourhood of Talwara, where artificial regeneration has been resorted to. The natural reproduction of other species is not satisfactory and that of *bija* (*Pterocarpus marsupium*) and *semal* (*Bombax malabaricum*) is particularly scanty. These trees seed well and innumerable seedlings appear at the beginning of the rains, but shortly afterwards perish ; in consequence, saplings of these species are almost entirely absent. In the Allapilli forests, *semal* has been found to send out a number of root suckers, and as many as ten well established poles were noticed round some trees. Experiments have therefore been started to encourage such reproduction by digging trenches one foot by one foot, in circles round *semal* trees, a system adopted with *Dalbergia sissoo* in the Punjab.

14. *Melghat*.—In the *Lantana* infested forests, eradication experiments indicate that uprooting in the rains followed by one or two weedings is quite practicable and effective. The admission of full light to the forest floor will result in a heavy crop of grass for the first few years which will prevent a re-infestation by *Lantana*.

Frost is likely to be a greater difficulty than *Lantana* with the introduction of the new plan. There are many variables connected with frost, and the divisional forest officer proposes to carry out a number of large scale experimental fellings to investigate the proper method of treatment. Thus various intensities of opening are being tried in the Sembadoh range, and the results will be compared. In two felling series of the Chaorakund range a strip system has been prescribed, designed to defeat the supposed adverse effects of the morning sun. Opinion, however, is now hardening in favour of the direct chilling effect of stagnant cold air being the chief cause of frost damage. Aspect and soil moisture are also considerations, and for the present fairly rough and easily applicable rules, based on the presence or absence of certain ecological associates, are all that can be given to marking officers for general guidance.

In the Melghat, teak is invasive wherever soil conditions are suitable for its growth: coppice growth in this division is generally poorer than elsewhere, probably as a result of the very wide range of day and night temperatures.

15. *Hoshangabad*.—The silvicultural problems of outstanding importance are those connected with the regeneration of teak in frost holes and in the bamboo infested forests of the Bori range. The technique of dealing with frost-bound depressions has now been standardised: these are carefully located and then subjected to fellings of a very conservative nature, designated frost protection fellings. The problem of dealing with bamboos awaits solution, and two sets of experiments are being conducted in this connection.

(1) An experimental plot divided into three sub-plots has been formed, and treated as under:—

Sub-plot A.—All bamboos cut in 1935.

„ B.—Bamboo culms of 1935 retained, all others cut.

„ C.—Only those bamboos cut which are actually over teak reproduction.

The overwood was then clear felled in all the sub-plots.

(2) In compartment 20, Bori felling series, which is due for conversion, advance fellings of bamboos and all unsaleable miscellaneous species have been made, and after the rains the question of burning the debris will be considered.

16. *Yeotmal*.—The report points out that moderate grazing everywhere appears to assist reproduction and that prolonged closure to

grazing is of no benefit. As in other divisions, the proportion of teak is increasing and this species is gradually but definitely spreading into mixed forests. The profuse reproduction of *dhaora* (*Anogeissus latifolia*) is very conspicuous in Yeotmal.

*Betul*.—In this report also, mention is made of the invasive tendency of teak in the mixed forests. Prolific bamboo reproduction is now found in the forests where bamboos flowered in recent years and the seedlings do not appear to have suffered from early fires. The coppice growth, even of *salai* (*Boswellia serrata*) is reported to be satisfactory in most felling series.

17. *North Chanda*.—Coppice has suffered severely from the browsing of deer, particularly in the western ranges, and this form of injury is likely to be a serious difficulty in the regeneration of these forests. The report stresses the great vigour of the coppice on fire lines and boundary lines, and attributes this growth to the controlled annual early burning of such areas.

18. *Sal Forests*.—In all the reports from the *sal* divisions stress is laid on the severe damage caused to *sal* reproduction by deer: the fenced plots in Balaghat show clearly the beneficial results of fencing and suggest that as long as vast herds of deer are allowed to infest these forests, their regeneration will be impossible. Light grazing by cattle, on the other hand, everywhere appears to assist reproduction.

19. The following is a summary of observations in regeneration experiments:—

*Survival of Sal Seedlings of 1933*.—As sufficient data were obtained and as identification of 1933 seedlings was becoming increasingly difficult, further investigations were discontinued. The experiment is summarised below:—

Twenty-four, 20'×20' fenced plots were formed in Bilaspur, Balaghat and Mandla divisions to observe the survival of seedlings after the prolific seed year of 1933. Three degrees of overwood cover were differentiated, open, moderate and dense, and eight plots were formed in each category. 6 counts were made and the results are tabulated below.

Division.	No. of plots.	NUMBER OF SEEDLINGS.					
		OPEN COVER.		MODERATE COVER.		DENSE COVER.	
		June 1934.	June 1935.	June 1934.	June 1935.	June 1934.	June 1935.
Bilaspur . . .	2	364	160	697	273	257	162
Balaghat . . .	2	259	*	605	*	168	*
Mandla . . .	4	162	212	514	186	382	126
Average per plot . .	.	98	62	227	76	101	48
Average per acre . .	.	10,672	6,752	24,720	8,276	10,999	5,227

\* Figures not received.

NOTE.—The figure shown is the total number of seedlings in all the plots in each division.

These figures indicate that moderate shade gives the best results, i.e., 76 per plot compared with 62 (open) and 48 (dense). It will be noticed that in Mandla, where there are four plots, the results are not nearly so good as in the other two divisions. The June count has been taken as the criterion because at that season most of the weak seedlings have been killed by the hot weather. The tallest seedlings reported are from Motinala range, Mandla division, namely 12 inches in June 1935. Elsewhere the seedlings are from 4" to 5" high.

20. *South Chanda Experimental Plot 1 (1927)*.—Observations have clearly demonstrated that provided ample advance growth of teak is present and other factors of locality are favourable, mixed forest with bamboos can be successfully regenerated with an almost pure crop of teak by clear felling and burning the felling debris for two years in succession. The bamboos, once a pest, have totally disappeared. The plot is fully stocked and the average height of teak is 20 feet.

*Experimental Plot No. 6 (1933)*.—This is an experiment to compare the progress of teak reproduction in areas heavily infested with *Petalidium barlerioides* when the weed is—

- (a) uprooted and burnt ;
- (b) left untouched ;
- (c) uprooted and removed ;
- (d) cut and removed ; and
- (e) cut and burnt.

Observations this year showed that under all the five treatments the weed has been reduced to a condition when it is no longer a serious obstacle in the way of teak seedlings which came up in 1934 ; but the plots are now over-run by a rank growth of grass which has completely smothered the seedlings. To-day once again the conditions are as unfavourable for teak reproduction as ever. Obviously recourse to artificial means will be the safest and the surest remedy.

21. *North Chanda Experimental Plot 6 (1931)*.—This is an experiment to determine the progress and development of teak seedlings under a complete overwood of teak with a dense underwood of bamboos when—

- (a) left untouched ;
- (b) bamboos and reproduction was cut back ;
- (c) bamboos were cut back but reproduction was left standing.

It has conclusively demonstrated that the removal of bamboos in advance of the overwood hastens the progress of reproduction and that complete regeneration is eventually obtained and the bamboos exterminated.

22. The following new experiment was laid out during the year:—

*South Chanda Experimental Plot 13.*—To compare the development of teak advance growth under a dense overwood when the advance growth is cut back and the overwood is—

- (a) left untouched ;
- (b) clear felled ; and
- (c) heavily opened out.

23. *Balaghat Experimental Plot 8 (1935).*—The object is to compare the development of well-grown *sal* advance growth (up to 24" G. O. B.) when the overwood is clear felled and

- (a) advance growth left untouched ;
- (b) advance growth clear felled.

The experiment is progressing satisfactorily.

The following new experiment was laid out during the year:—

24. *Raipur Experimental Plot 1.*—To compare the rate of regeneration of *sal* after the overwood is clear felled in 1936 and subsequently—

- (a) left untouched ;
- (b) stacked and burnt in June 1936 ;
- (c) stacked and burnt in June 1936 and again in June 1937 ;
- (d) Stacked and burnt only in June 1937.

25. *Other Species.*—

*Bhandara Experimental Plot 1.*—The object here is to observe the progress of natural reproduction of *rohan* (*Soymida febrifuga*). Reproduction continues to progress very slowly. The 6' established stocking factor at the last four measurements was:—

Year.	1930	1932	1933	1936
Factor . . . . .	4.26	4.59	6.67	8.50

It is very unlikely that the conditions will improve and a change in the treatment is contemplated.

### (iii) *Seeds.*

26. Most species seeded satisfactorily except *mahua* (*Madhuca latifolia*) and *achar* (*Buchanania lanzan*), the fruit of which was destroyed by hail and wind-storms. In the Damoh division the tapping of *kulu* (*Sterculia urens*) is said to have seriously impaired its powers of reproduction. General flowering of bamboos is reported in the Sironcha range of the South Chanda division.

The Silviculturist again acted as a distribtng agency for seed, both inside and outside the province.

## (iv) Nurseries.

27. The most important work of the year was again undertaken in the South Chanda division, where 2,400 lbs. of seed collected locally was used in the Talwara and Allapilli nurseries for the plantations in the Allapilli range, 1,000 lbs. was used in the Kopella nursery for the plantations in the Sironcha range, and small nurseries were also maintained at Elchil and Kanhargaoon for forming experimental plantations in the vicinity.

28. In the Saugor division the new working plan has prescribed an annual planting programme of 40 to 50 acres in the Ramna block : the nursery which has been made to supply the transplants was extended during the year and 25,000 teak seedlings are reported to be ready for transplanting in the present rains.

29. Numerous small nurseries are maintained in other divisions to supply transplants for experimental plantations and for agri-silvicultural operations. The chief of these are the following :—

Division.	Locality and species.
Saugor . . .	Ramna (teak).
Nimar . . .	Morud (teak).
Melghat . . .	Sembadoh and Chikalda (teak and <i>Ougeinia dalbergioides</i> ) Paratwara ( <i>Azadirachta indica</i> ).
West Berar . . .	Chikhli and Balapur ( <i>Bambusa arundinacea</i> and <i>Dendrocalamus strictus</i> ). Amdari ( <i>Acacia cyanophylla</i> ).
Yeotmal . . .	Umarda and Morchandi ( <i>Bambusa polymorpha</i> and <i>Dendrocalamus strictus</i> from various localities). Pandhardevi (teak).
North Chanda . . .	Ghantachowki and Moharli (teak). Rambagh ( <i>Swietenia mahogany</i> ).
Nagpur-Wardha . . .	Umrer and Chorbaoli (teak and <i>Bombax malabaricum</i> ).

## (v) Artificial Regeneration.

30. Artificial regeneration on a large scale is at present carried out only in the Allapilli teak forests, in North Raipur, and in the agri-silvicultural operations in Berar : an extension of such work is prescribed in the recent working plans for the Saugor and North Chanda divisions.

Details of the chief operations undertaken during the past year are given below :—

*Agri-silviculture.*

31. *Yeotmal*.—Artificial restocking with teak by the *rab* method, i.e., by piling and burning all slash on the seed-bed to kill all undesirable

seed before planting teak, has been very successful in this division. Experience has shown that the requirements for success are a good, deep, well-drained soil and a demand for culturable land. The tree species should be introduced in the third year of cultivation and timely and thorough weeding must be insisted upon.

In this division and in the West Berar division it has been found in agri-silvicultural operations that teak does well on good soils and *Acacia catechu* on the poorer soils. *Gmelina arborea* and the American variety of *Prosopis juliflora* show considerable promise. Other species which are being tried with varying degrees of success are *Acacia arabica*, *Albizia lebbek*, *Dalbergia latifolia*, *Dalbergia sissoo* and *Pongamia pinnata*.

32. Details of the work done during the year are given below :—

*Pandhardevi* (56 plots).—596 acres were sown with teak (2,241 lines), *Acacia arabica* (220 lines), *Acacia catechu* (232 lines), *Dalbergia latifolia* (121 lines), *Gmelina arborea* (401 lines), *Dalbergia sissoo* (40 lines) and *Terminalia tomentosa* (115 lines) between the 6th and 8th June 1935. The lines were 15 feet apart and the intervening spaces were sown by plot-holders with *juar* (*Sorghum vulgare*) and cotton. All species except teak germinated satisfactorily and in March 1936 the height of the seedlings was as follows :—

Species.	HEIGHT IN INCHES.	
	Average.	Maximum.
	Inches.	Inches.
<i>Acacia arabica</i> . . . . .	20	76
<i>Acacia catechu</i> . . . . .	5	13
<i>Dalbergia latifolia</i> . . . . .	4	8
<i>Dalbergia sissoo</i> . . . . .	4	8
<i>Gmelina arborea</i> . . . . .	5	33
<i>Tectona grandis</i> . . . . .	4	12

The teak rows were reinforced in 10 plots by putting in 22,869 root and shoot cuttings and 234 seedlings. Of these only 5,311 cuttings and 24 seedlings survived by March 1936, and were from 4 to 13 inches and from 5 to 8 inches in height respectively. These plots are by no means fully regenerated and will be resown with teak and *Acacia catechu* during the rains.

33. *Borwadi* (18 plots).—In each plot an area of 0.75 acres was cleared of all stumps, and a layer of one foot of fuel was piled on the site and burnt. The plot was then thoroughly ploughed and harrowed. Teak

seed was sown in lines 6 feet apart with *Dalbergia latifolia* in every sixth row. The germination of teak was poor but that of *Dalbergia latifolia* was good. In order to fill up gaps 8,736 teak seedlings were transplanted from last year's plots. Towards the end of August 75 per cent. of the seedlings appeared healthy but at the beginning of September a large number were attacked in the roots and killed by the larvae of *Lachnosteria*. Casualties were further increased by the flooding of the plots. In spite of these set-backs, 16 out of the 18 plots are fully stocked with teak, and the plants are from 10 to 20 inches in height. The understocked plots will be planted again in the coming rains. Areas planted last year (4½ acres in 18 plots) are looking very well and the plants are from 6 to 11 feet in height.

34. *Kinwat* (3 plots).—The work is here done departmentally. 13 acres of well-stocked Central Provinces III quality mixed forest was clear felled in March 1935. The debris was collected in heaps over the large stumps and was burnt, first in April and again in May. The soil was thoroughly worked and sown in June with teak in lines 6 feet apart, with cotton between the lines. Germination started early in July and was good in all the plots: the seedlings were weeded in July and again in August. The plots are fully regenerated and the seedlings from 8 to 20 inches high. The total cost, excluding supervision charges, amounted to Rs. 10.5 per acre, and the revenue from the sale of cotton to about Rs. 6 per acre. Cotton is being sown again this year and it is hoped that the net result will be a clear financial profit as well as a successful plantation.

35. *Nimar*.—The operations again proved a failure owing to the indifference of the cultivators, and it is now proposed to resort to planting.

36. *Melghat*.—The agri-silvicultural operations referred to in last year's report were extended to six more plots. In the mature plots at Chikalda the final planting up with root and shoot cuttings of *Ougeinia dalbergioides* will be carried out during the rains. On the whole the experiment has been very successful and a group of cultivators is being carefully trained in what is required. If properly carried out, this is a very satisfactory method of getting rid of *Lantana* and of afforesting the poor, plateau type of open forest. The sowing of *Strobilanthes* and *Tephrosia* has been abandoned as it is found that the grass regrowth is sufficient to keep down *Lantana* seedlings.

#### *Plantations.*

37. *South Chanda*.—Teak plantation work continued satisfactorily; details of the year's work are given below:—

In periodic block I areas in compartment 33 near Talwara, 43,025 root and shoot cuttings and about 200 *dona* or leaf-cup plants were

planted with a spacing of 12 feet by 12 feet during the rains. 4,200 casualties were replaced at the time of weeding. The total cost of the operations, including weeding, was about Rs. 7 per acre, which is not high considering the satisfactory results.

38. *North Chanda*.—Small areas planted up in 1934 were successfully regenerated at a cost of Rs. 20 per acre and fresh work was undertaken during the year, teak, *bija* (*Pterocarpus marsupium*) and *Dalbergia sissoo* being planted with a spacing of 9 feet by 9 feet. Root and shoot plants have been found to grow more rapidly than *dona* plants.

39. *Bilaspur*.—In the South Laon range two plantations were made, one of 27 acres in compartment 316 at a cost of Rs. 229 and the second of 8 acres in compartment 311 at a cost of Rs. 108. In the former, teak and *shisham* were planted in the proportion of two to one, and in the latter in equal proportions. The average and maximum height in March 1936 of each species in each plantation was as follows:—

Species.	Maximum height.	Average height.	Percentage of casualties.
<i>Compartment 316, Coupe VII.</i>			
	Ft. In.	Ft. In.	
Teak . . . . .	4 6	11 4	4.4
<i>Shisham</i> . . . . .	1 8	8 2	12.2
<i>Compartment 311.</i>			
Teak . . . . .	3 0	9 5	8.8
<i>Shisham</i> . . . . .	1 0	0 6	34.8

Teak plantations on an experimental scale were made in several other divisions.

40. *West Berar*.—Propagation of hamhoos:—

(a) *By rhizomes*.—This was attempted on a small scale. 256 one-year-old culms with a part of the rhizome were transplanted during the rains. In April few appeared to be living.

(b) *By mulching*.—Seedlings transplanted between 1931 and 1933 were not growing satisfactorily. 2,500 were mulched in November and December 1935 and the seedlings are now looking healthier and more vigorous.

41. *All-India teak seed origin investigation*.—These plantations in North Raipur are now well established and have conclusively shown that imported seed does not give such good results as that of local origin.

*5-year old teak crop raised from local seed.*

The general history of the plantation is as under :—

Prior to planting the area contained Central Provinces III quality mixed forest with bamboo, and no teak. Altitude 1,250'. Annual rainfall, 55"-60". Rock, Dharwar schists. Soil, deep reddish brown sandy loam with loose boulders. Slope, moderate. Aspect, northerly. Clearfelled, April 1931. Debris piled and burnt end of May. An area of 509 acres planted up, 6 feet by 6 feet with 600 teak seedlings raised from local (Tenduchua, North Raipur) seeds, in *donas* (leaf-cups) in June. Weeded whenever necessary. Cleaned and measured in December 1934 with the following results :—

Stems retained after cleaning . . . . .	504
Proportion of well-grown stems . . . . .	75 per cent.
Height—Maximum 23', Minimum 6-5'.	

*5-year old teak crop raised from imported seed.*

Description same as for above. Except that instead of local seed, seed obtained from Nilambur (Madras) was used. Cleaned and measured in December 1934 with the following results :—

Stems retained after cleaning . . . . .	546
Proportion of well-grown stems . . . . .	32 per cent.
Height—Maximum 26', Minimum 19'.	

The teak grown from local seed is much less branchy and of more open habit than the Nilambur teak.

NOTE.—For further description see last year's report.

(vi) *Reclamation and Afforestation.*

42. *Jubbulpore*.—Several areas forming the headwaters of tributaries of the Nerbudda are subject to erosion: with a view to determine a method of reducing this damage an experiment has been started on an area of 5 acres. Dams have been constructed across the upper reaches of the smaller nalas in places where erosion was starting, and stumps of *salai* (*Boswellia serrata*) and *moyen* (*Lannea grandis*) planted. Most of the stumps sprouted but died before March.

(vii) *Tending—Thinnings and Cleanings.*

43. *Thinnings*.—Thinnings in most divisions are now confined to congested forests where they are urgently needed. The Nimar report remarks that difficulties experienced in conducting these operations are to decide what degree of unsoundness at the base should justify the removal of teak trees in thinnings, and how far it is admissible to open the canopy in areas liable to frost damage.

44. As a result of successful regeneration operations during the last ten years, there are now extensive young teak, *sal* and mixed forests in many divisions. It is important to determine the proper thinning regime in these young crops and the following experiments have been recently started with this purpose.

45. *Chhindwara experimental plot 5*.—The object is to determine the correct degree of thinning, both from a silvicultural and a financial point of view, in a naturally regenerated, 8-year old, teak forest. Four sub-plots have been formed; the degree to which each has been thinned is shown in the statement below :—

Sub-plot number.	Thinning Grade.	NUMBER OF STEMS.	
		Before thinning.	After thinning.
Control . . . . .	Unthinned . .	1,806	1,806
A . . . . .	A grade . .	1,873	840
B . . . . .	B grade . .	1,560	467
C . . . . .	C grade . .	1,647	240

46. *Melghat experimental plot 1*.—To compare the rate of growth in a 20-year-old teak plantation when (i) left unthinned, (ii) mechanically thinned and (iii) silviculturally thinned.

*Melghat experimental plot 2*.—To compare the rate of growth in a naturally regenerated 20-year-old teak forest when (i) left unthinned, and (ii) thinned C grade.

47. *Betul experimental plot 14*.—To determine the age or size at which first thinnings should be made, and the correct manner of carrying them out in a naturally regenerated teak forest.

48. *Nagpur-Wardha experimental plot 1*.—This experiment was laid out in the previous year to determine the best method of thinning teak stool shoots. Observations at present suggest that the retention of all the shoots retards the growth of the vigorous shoots. On the other hand, the retention of only the most vigorous shoot does not result in such rapid growth as would compensate for the sacrifice of all other vigorous shoots that would have grown to marketable size, especially as the isolated shoots tend to throw out epicormic branches. Thus it already appears that the best procedure will be to retain 2 or 3 dominant, vigorous, well-formed shoots on each stump, and to remove all others in the first thinning at the age of from 5 to 10 years.

*Cleanings.*

49. *South Chanda experimental plots 7 to 10.*—Replicated plots were laid out during the previous year to determine the best method of getting teak stumps established in plantations heavily infested with bamboos and weed regrowth. The growth of the transplants under four different treatments was as follows :—

Treatment.		Average height of transplants in January 1936. Feet.
C January 1935.	All bamboos and weeds cut back.	
August 1935.	Operations repeated . . . . .	8.3
D January 1935.	All bamboos and weeds cut back.	
	Untouched thereafter . . . . .	7.55
A January 1935.	Only overhanging bamboos and interfering weeds removed.	
August and November 1935.	Operations repeated . . . . .	7.2
B January 1935.	Only overhanging bamboos and interfering weeds removed.	
August 1935.	Operation repeated . . . . .	6.65
E Control.	Left untouched . . . . .	6.45

There are very few casualties, which were shared equally by all the sub-plots. The results show that the more thorough and frequent the cutting back of the bamboos, the better the height growth of the teak stumps, but it is doubtful whether the difference is sufficiently great to justify the added expenditure. The teak plants in the sub-plots in which the bamboos were left uncut, though not so high, actually appear to benefit from the side shade, as they are more vigorous and retain their foliage longer. It would thus appear that the repeated cutting of the bamboos will hardly be necessary and the experiment has therefore now been closed.

The divisional report, on the other hand, suggests that teak in the plantations cannot hold its own against *Petalidium*, bamboos and grass unless it is helped during the first two years. It is now therefore proposed to make small experimental plantations under shade in coupes due for working five years hence, so that the young teak may be established by the time the fellings are due. In the North Chanda division, advance fellings of the bamboos have been prescribed in order to assist the teak natural reproduction to become established before the overwood is removed.

50. The following are matters of interest mentioned in other divisional reports :—

*Lantana aculeata.*—In the Melghat division, the roadside eradication of this pest has now reached a stage when the resulting grass defeats the seedling growth of *Lantana*. Now that roadsides are clear to the

requisite distance, it is becoming increasingly easy to maintain them in this condition. The effectiveness of these measures both as regards fire protection and the preservation of the amenities of Chikalda is beyond question. During the rains of 1936 *Lantana* is to be uprooted with the help of elephants in the first three coupes of the new working plan, as such clearance is the first essential to the working of these areas.

*Lantana* is still a serious pest in a remote part of the Bori range in the Hoshangabad division, and it is now proposed to form a forest village in this locality to provide labour for eradication.

51. *Mucuna pruriens*.—In Yeotmal, cutting of this climber in August and again in September for two successive years after the main fellings is found preferable to uprooting, as the latter operation is more expensive and both methods are equally effective. In the South Chanda division the seedlings of this climber were uprooted by hand during the planting operations. This did not appreciably add to the cost of planting and the results have been satisfactory.

52. *Bauhinia vahlii*.—In Betul, it is remarked that the five-yearly cutting of this climber merely results in more vigorous and more numerous shoots than before. It is suggested that a better procedure would be either to uproot it or to cut it annually for five years, starting two years before the main fellings, and each time to smear the cut end with coal tar. If this is impracticable, it would be preferable not to cut the climber at the time of the main fellings. In Chhindwara the same conclusion has been arrived at, and it is suggested that the climber should be cut five years after the main felling, when it is more likely to be suppressed by the reproduction.

53. *Zizyphus oenophia*.—The control of this pest is found to be very difficult in Hoshangabad. It is cut two years ahead of the main fellings and also whenever the forest is thinned, but these measures are ineffective. The cutting of this climber has now become urgently necessary in areas regenerated in 1928-29.

#### (viii) *Mixtures.*

54. The invasive tendency of teak and its tendency to grow pure and to oust all other species, especially after clear fellings, have already been mentioned. To counteract this tendency several recent plans have prescribed the reservation of trees of miscellaneous species in conversion operations and their favouring in cleanings and thinnings. It is now argued by some officers, however, that such reservations will fail in their object and that ecological and other factors are so overwhelmingly in favour of the teak that we are powerless to prevent an inevitable natural succession. Others say that we should at least apply

sanctions against the teak, even if they are doomed to failure, of which we cannot at present be certain.

### (ix) *Underplanting.*

55. It is now suggested that in teak forests with a dense underwood of bamboos or weeds but deficient in natural reproduction of teak, satisfactory regeneration is probably best obtained by underplanting teak some years in advance of the removal of the overwood. To investigate this possibility, the following experiments were laid out during the year :—

*South Chanda experimental plot 12 and North Chanda experimental plot 8.*—The objects of these experiments is to find out if mature teak forests in which natural reproduction is deficient or absent, can be successfully and cheaply regenerated by underplanting with root and shoot cuttings of teak, so that the stumps may become established before the overwood is clear felled : in the South Chanda plot the overwood is chiefly grass, in North Chanda bamboos.

### (x) *Silvicultural Systems.*

56. Experience in conversion operations in the teak forests of the Central Provinces during the last ten years has evolved the system of coppice with reserves, the elastic provisions of which have proved its suitability in forests in which widely diverse types of growth are found in almost every coupe. The advantage of this system is that each patch of forest in each coupe can be treated strictly according to its silvicultural needs. The treatment may thus vary in a single coupe from clear fellings in areas with adequate advance growth to very conservative treatment in frost holes or on steep slopes and areas liable to erosion : in forests capable of growing somewhat larger timber, immature poles of valuable species may be retained to form a part of the future crop.

The new working plan for the Melghat division embodies the latest ideas of this elastic conversion system, which must be employed with care in this division owing to the danger of frost and drought.

In the Nimar division the flexibility of the prescriptions has made it possible to adapt them to suit the conditions in each coupe, but the differences in interpretation of the rules by succeeding officers, which are inevitable in the early years of the introduction of a new system, sometimes tend to perplex range officers in their application of the prescriptions. There have thus been constant modifications in the method of treatment and the position has been rendered more difficult by the severe frosts of 1934 and 1935 which have seriously upset calculations.

57. In the Betul division the development of the charcoal industry and of the road system are resulting in fuller exploitation, and during the year it was decided to work two improvement felling series in the Saoligarh range under the conversion system. The bamboos have died after gregarious flowering in several ranges and for some years are likely to be a serious hindrance in conversion operations. Efforts have been made to burn them but have not been very effective.

58. In the Chhindwara report it is suggested that certain high forest felling series could be more suitably worked under a shorter rotation, as the chief local demand is for poles and fuel.

59. In the teak plantation operations in the Bilaspur division, it is proposed this year to plant up only mixed forest areas in which there is at present no teak. To maintain a suitable mixture the teak will be given wide spacing, so that the bamboos and the coppice of other species may not be suppressed. In the dry North Raipur forests it is reported that the system of simple coppice is often unsuitable as it leads to excessive soil exposure. The system of coppice with standards under which the sal forests are worked is also criticised, as the sal standards reserved develop prolific epicormic branches and are not likely to produce good timber.

60. In the Jubbulpore division, the prescriptions of the new working plan are reported to be working satisfactorily in the Mandla ranges. In the sal high forests of the Murwara range, the uniform system has failed on account of repeated frost damage. Strip and selection fellings have been made departmentally but a satisfactory system has still to be evolved.

(xi) *Miscellaneous.*

61. *Grazing.*—In Hoshangabad and other divisions the premature opening of coupes to grazing after a closure of only five years after the main fellings has not resulted in any noticeable damage by cattle to the young crop and has considerably reduced the danger of fire; this practice is therefore being developed. In the regenerated coupes of the coppice working circles in the North Raipur forests, which have now been closed for eight years, it has been noticed that wherever density is low, the coppice has suffered from the rank growth of grass and from the browsing of wild animals and it is suggested in the divisional report that coupes might with benefit be opened to light grazing for a part of the year 3 or 4 years after the main fellings. In the South Raipur forests experiments have been made in young woods, 7 or 8 years old, to test the effect of light grazing up to the end of the rains: no adverse effects have been noticed. In West Berar the premature opening of coupes to reduce the cost of fire protection was found very satisfactory.

There is thus a tendency in many divisions, particularly in teak forests, to reduce the period of closure to not more than 5 years; the fire danger is thus reduced, browsing by deer is less injurious and the grazing facilities for the local cattle are at the same time improved.

62. *Frost*.—In recent years late frosts have caused severe damage to young forest crops, especially teak, and a great deal of attention is now being given to a study of the problem. During the year the Conservator, Western Circle, wrote a note on the subject after a tour in the Nimar division. A summary of his observations is given below :—

Frost has done severe damage to forest crops in three of the past eight years. The dates of these frosts were :—

29th to 31st January 1929.

19th onwards January 1934.

16th onwards January 1935.

In young crops severe frost kills the shoot but not the root and thus injury amounts to a cutting back, resulting in loss of increment and sometimes malformation of the bole.

The liability of various species to damage is as under :—

*Severely affected* :—

Teak, *Albizzia procera*, *Emblia officinalis*, *Madhuca latifolia*,  
*Buchanania lanzan*, *Bombax malabaricum* and *Kydia calycina*.

*Affected* :—

*Terminalia tomentosa*, *Lannea grandis*, *Stephygyne parvifolia*,  
*Boswellia serrata*, *Ougeinia dalbergioides* and *Lagerstroemia parviflora*.

*Immune* :—

*Anogeissus latifolia*, *Acacia catechu*, *Acacia leucophloea*, *Zizyphus jujuba*, *Hardwickia binata*, *Butea frondosa*, *Diospyros melanoxylon* and *Dendrocalamus strictus*.

Clear felled areas suffer most and the retention of a part of the advance growth of miscellaneous species does not greatly improve matters. The prevalent theory is that beating of the direct rays of the morning sun and consequent rapid evaporation of the dew causes frost bite. If this is admitted then the attempts made of late, to regenerate in NE—SW strips is sound in principle, but the retention of narrow 50-foot strips of poorly stocked forest will be ineffective, especially in the drier localities where teak sheds most of its leaves by the time frost is expected. The Melghat scheme of successive strips where the width of the unfelled strip at any time is three times that of the felled strip is more likely to be successful.

63. Discussing the problem the Conservator (Mr. C. M. Harlow) observes :—

“ The worst frost occurs in the flat land, and the steeper the slopes the more confined its effect. Frost seems to be a question of the speed of drainage of the cold air, which in its turn appears to follow the course of the water drainage. Where the gradients of the nalas are steep the cold air can drain down quickly and there is no damage ; where the country is flat and the gradients of the nalas slight the cold air cannot get away quickly and damage results.

The presence of miscellaneous species does not seem to minimise the damage. Strip fellings against the morning sun do not look very hopeful either. Improvement fellings are worse than useless, for not only does the reproduction get frosted back but the smaller standing timber is also ruined. Selection in the form of heavy thinnings and opening up over advance growth is equally bad. The only thing that seems to confer any immunity from frost is no interference with the canopy, which means no fellings at all where the canopy is already thin or interrupted as is often the case.”

64. Mr. Harlow is not hopeful of finding a solution. From observation and enquiry he concludes that during the period of growth of the present overwood severe frosts have been rare, as otherwise at least some of the boles would certainly have been defective or there would have been some record of the frosts in the boles. If climatic conditions have radically changed and severe frosts like those of 1929, 1934 and 1935 are likely to recur frequently in future the forests are doomed. If, however, it can be proved that similar severe frosts have occurred in the past followed by long periods of immunity, such as the period during which the present woods grew, and that such a phenomenon is cyclic, then there is hope, and before the next period of heavy frost we can look forward to a period of immunity during which our forests will be able to grow up and reach a stage when the frosts can only injure their crowns.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

65. No new plans were sanctioned during the year. The following plans are now under revision :—

- (1) *North Chanda.*—The premature revision of this plan was necessary owing to the difficulty experienced in regenerating forests in which there is a dense undergrowth of bamboos ; the new plan therefore reduces the areas under conversion and provides for advance fellings of bamboos to stimulate

tree reproduction, and for artificial regeneration in suitable places. Teak, *bija* and *semal*, the most valuable timbers, have been enumerated in the high forest working circle with the object of finding the proportions of trees of the different diameter classes and of regulating the future yield. The plan has been completed and has been sent to Dehra Dun for criticism.

- (2) *Melghat*.—This plan has been completed and submitted to the Chief Conservator. It is based on a complete stock-mapping and introduces conversion systems for the first time in this important division. Frost is a great danger in certain localities, and the plan prescribes strip conversion fellings in two felling series. Special provision is made for the eradication of *Lantana* in advance of the main fellings.
- (3) *Damoh*.—This plan has also been completed and is now with the Chief Conservator. Its most interesting features are its prescriptions for the rotational working of lac host trees and for the rotational tapping of *kulu* (*Sterculia urens*) for gum.
- (4) *South Chanda* (excluding Allapilli and Pedigundam).—The field work is completed and the final report will probably be submitted during the rains.
- (5) *Yeotmal*.—The field work has been completed; the plan will probably be introduced from 1st July 1937.
- (6) *Raipur mixed forests*.—The revision had been undertaken by the divisional forest officer and has been submitted to the Conservator.

During the next touring season it is expected that the revision of the North Raipur, Buldana and Hoshangabad plans will be taken in hand.

66. Among a large number of amendments issued, the following were the most important :—

- (1) *Nimar*.—The schedule of grazing units was completely revised in order to improve grazing facilities.
- (2) *Akola*.—Part II of the plan was entirely rewritten. There are no radical changes in the prescriptions but only modifications to incorporate changes which experience has shown to be necessary.
- (3) *Bilaspur*.—The felling rules for the high forest working circle were revised to bring the treatment of these forests into line with the methods now in vogue in other parts of the province.

(ii) *Yield Volume and Form Factor Tables.*

67. *Sample plots.*—There were 112 sample plots on the provincial list at the beginning of the year, of which four were converted into tree increment plots. Three new sample plots were laid out, thus bringing the total to 111. The sample plots now cover a wide range of age and quality and are considered adequate to provide the necessary data for the preparation of reliable volume tables. Such tables for *sal* and *teak* are now under preparation at Dehra Dun. The distribution of plots according to species is as follows :—

Species.	Number.
<i>Tectona grandis</i> . . . . .	65
<i>Shorea robusta</i> . . . . .	38
<i>Pinus longifolia</i> . . . . .	2
<i>Cleistanthus collinus</i> . . . . .	2
<i>Chloroxylon swietenia</i> . . . . .	1
<i>Acacia arabica</i> . . . . .	1
<i>Terminalia tomentosa</i> . . . . .	1
Miscellaneous species . . . . .	1
<b>TOTAL</b> .	<b>111</b>

68. *Tree increment plots.*—There were 6 tree increment plots at the beginning of the year, to which four were added, bringing the total to 10 at the close of the year. The distribution by species is as follows :—

Species.	Number.
<i>Tectona grandis</i> . . . . .	1
<i>Shorea robusta</i> . . . . .	5
<i>Pterocarpus marsupium</i> . . . . .	1
<i>Chloroxylon swietenia</i> . . . . .	1
<i>Hardwickia binata</i> . . . . .	1
Miscellaneous species . . . . .	1
<b>TOTAL</b> .	<b>10</b>

69. *Experimental plots.*—There were 29 experimental plots at the opening of the year. Two plots which were erroneously abolished in previous years were again taken on the list, and 10 new plots were laid out during the year, thus bringing the present total to 41. Details of the new experiments have been given in previous paragraphs of this report.

*Measurements.*—All measurements due during the year were carried out.

## III.—Miscellaneous.

70. The office of Silviculturist was held by Mr. H. C. B. Jollye throughout the year, except for very short periods at the beginning and end of the year when Mr. K. P. Sagreiya, and Mr. H. C. Watts occupied the post.

## COORG.

## I.—EXPERIMENTAL SILVICULTURE.

*Seed.*

1. *Teak seed pre-treatment experiments.*—The treatments used are soaking 48 hours, soaking 24 hours, weathering in a shallow pit, and scorching, with an untreated control. Soaking 48 hours and the dry control have so far given the best results, i.e., 41 and 38 per cent., as compared to 37, 14 and 13 per cent. in the other cases.

2. *Sandal germination test.*—The following treatments and kinds of seeds were used :—Soaking 5 days, 10 days and 15 days ; floaters after  $\frac{1}{2}$  hour and 24 hours immersion ; sinkers after  $\frac{1}{2}$  hour and 24 hours immersion ; plantation tree seeds, natural tree seeds, beds shaded and unshaded, seeds with and without pulp, spiked tree seeds, ditch seeds 15 days treated and 3 and 4 venated seeds.

Seeds without pulp gave the best results, i.e., 37 per cent. Plantation tree seeds and untreated control gave 30 and 22 per cent. germination.

3. *Andamans Padauk (Pterocarpus dalbergioides) germination test.*—The treatments used are (1) soaking 48 hours, (2) dumping and notching the germinating seeds, (3) covering the seed bed with twigs and straw, (4) soaking 48 hours and shading the beds 33, 66 and 100 per cent.

The results are as follows :—36, 20, 48, 23, 27 and 25 per cent. germination respectively. Beds covered with twigs and straw have thus given best results.

4. *Artocarpus hirsuta germination test.*—The methods adopted are (a) seeds extracted and sown immediately, (b) seeds preserved for one month, (c) fruits preserved for one month and sown in open bed, beds shaded 50 and 100 per cent.

The results are 54, 11, 10, 11 and 7 per cent. germination respectively. Seeds extracted and sown immediately have given best results.

5. *Bambusa polymorpha.*—2 lbs. of seeds were sown in open beds. The germination was 80 per cent. and there were about 50 per cent. of the seedlings surviving at the end of the year.

*Sandal Regeneration.*

1. Experiments to determine the best date of sowing, stumping and transplanting sandal in open and in forest where the density of the canopy is 0.4 and 0.7 were tried. The stocking of seedlings is best in forest where the density of the canopy is 0.4. The best dates are :—sowing on 15th May, transplanting and stumping on 15th June.

2. Experiments on sowing sandal in open and under bushes were tried and 80 per cent. germination and survival was recorded under bushes, as compared to 69 in the open.

3. The method of regenerating sandal by propagation centres and in basket fences was continued during the year. In all, 212 propagation centres and 286 basket fences were opened and plants are established in almost every one of these.

### *Artificial Regeneration of Teak.*

1. *Pre-monsoon stump planting of Teak.*—This experiment was repeated during the year and the indications are :—(a) the best dates for stump planting are 15th April and 2nd May, (b) the improvement in growth is maintained in the 2nd year also.

The heights reached after one year for the two best dates of stumping compared with dibbling are 59" and 43" compared with 11".

2. *Effect of kumri crops on the growth of teak in a plantation.*—Hill paddy, *ragi*, *ragi* with *dhal* were tried. Teak seedlings were very small from 3" to 9" in height at the end of the year, and definite results can be had only at the end of the 2nd year of growth.

3. *Best planting distance of teak and its effect on the growth of teak.*—Experiments were started with three espacements, 3'×3', 4½'×4½' and 6'×6'. The germination was 70 per cent. and survival of seedlings at the end of the year was only 40 per cent. The cost at the end of the 1st season was Rs. 17-8-0, Rs. 25-12-0 and Rs. 47-2-0 per acre respectively for three espacements. This is a long term experiment and will be under observation in future.

4. *Cover crops.*—*Tephrosia candida* (*boga*) introduced in the 1st year of a teak plantation.

The results of three experiments are as follows :—

	Survival per cent.	Mean height.
Boga . . . . .	80	15.4"
Control . . . . .	83	17.3"

The results indicate that *boga* has done no good and has retarded the growth of teak by 11 per cent. Weed growth is suppressed to some extent, but before long *boga* will have to be cut back to protect teak from being snppressed.

5. To compare (a) weed knifing, (b) aeration by forking and (c) scraping with hoe, to determine its effect on the development of teak during the 2nd year of formation.

The height development of plants in (b) and (c) compared with (a), are 7·8" and 8" as compared with 7·3". The results show that scraping is as good as forking.

6. *Direct sowing of teak*.—Comparison of (a) soil aerated in burnt and unburnt plots, (b) plots burnt and not burnt and soil not aerated.

The results show that hurning and aerating the soil gives good percentage of survival and mean height. Burning only has given better results than the plots where burning has not been done. This shows that hurning does stimulate the growth of teak in the initial stage. The results are summarised as follows :—

	Survival per cent.	Mean height.
(a) Burnt and soil aerated . . . . .	87	59"
(b) Not burnt and soil aerated . . . . .	85	40"
(c) Burnt and soil not aerated . . . . .	88	44"
(d) Not burnt and soil not aerated . . . . .	98	32"

7. *Effect of underplanting teak areas with Dalbergia latifolia*.—Half an acre plots are opened in 1935, 1934 and 1933 regeneration areas and rosewood plants are planted at an espacement of 12'×12' in between teak. This is a long term experiment and the plots will be under careful observation in future.

8. *Teak seed and stump origin experiments*.—The seeds and stumps of Nilambur and Mysore origin were tried and the results are as follows :—

Origin.	STUMPS AT THE END OF THE 1ST YEAR.		SEED AT THE END OF 2ND YEAR.	
	Survival per cent.	Mean height.	Survival per cent.	Mean height.
Nilambur . . . . .	87	14·3"	95	28·2"
Mysore . . . . .	87	10·7"	76	15·8"

The above data indicates a 79 per cent. increase from seed and 33 per cent. from stumps of Nilambur origin.

9. *Teak seeds of Coorg and Mysore origin*.—Two experiments were tried to find out as to which gives better result.

The germination of Mysore origin was 76 per cent. and that of Coorg 61 per cent. Seedlings are only 3 to 9 inches in height and their development will be watched in the current year. Coorg gets a supply of teak seeds from Mysore for artificial regeneration works.

10. *Effect of burning and cutting back a teak plantation in the 2nd year of formation*.—Experiments were carried out in the last two years and the indications are as follows :—

- The height growth of plants is better than in control.
- This improvement is maintained in the 2nd year also.
- Weed growth after burn is not so dense and noxious as it was before the treatment.

*Miscellaneous.*

1. To study the growth of sandal in plantations with teak as hosts.

Observations in the last year's experimental plot at Junglebadi was continued during the year. The stocking of sandal is 60 per cent. and mean height is about 4' 6". The stocking of teak is about 80 per cent. and mean height is about 16".

This is a long term experiment and observations will be continued.

2. *Sample trees and sample plots.*—These are maintained and measurement of trees are recorded carefully.

3. *Sandal spike disease.*—Fresh cases of spike were found in three villages in North Coorg and control operations were carried out promptly.

In all 1468 spiked sandal trees were treated with Atlas and killed during the year.

4. *Sandal observation area.*—This is an area of 12 acres, opened with the object of protecting the bit from spike disease and assist the growth of sandal by tending, thinning, etc.

In this area 7 plots were laid, 4 as control and in 3 thinning, introduction of hosts and uprooting of *Lantana* was done. A general tending was carried out over the whole area. Spike disease is prevalent round about and control operations have been carried out. This area contains 1842 sandal plants and trees and it works out to 153 per acre.

During the year we had 7 occurrences of spike in the area and they were treated with Atlas and trees round about were lopped.

This is a long term experiment and the area will be under careful observation.

5. *Teak defoliation experimental areas in South Coorg.*—Periodical measurements in teak defoliation experimental areas were recorded during the year. In general, defoliation was not severe in Eastern forests, but in Makut teak plantation the trees suffered heavily from defoliation.

*Makut Evergreen Rain Forest.*

1. *Study of the survival, development and increase of natural regeneration of valuable species when tended according to instructions in the working scheme, and other valuable species introduced artificially (1934-35 experiment continued).*

A 1934 coupe of 53 acres was taken up and 126 gaps caused by fellings were selected for observation. An enumeration of natural regeneration was recorded and *Hopea* transplants and bamboo cuttings were introduced into these gaps.

This coupe is divided into 5 strips and in four rubbish felling was carried out and the fifth was left as control. Here 12 gaps, 6 in rubbish felled area and 6 in the control bit, are selected for careful study. Periodical enumeration of regeneration is taken and recorded. Particulars of regeneration are given below :—

Particulars.	Rubbish felled strip, 6 gaps.	Control, 6 gaps.
January 1935 . . . . .	78	79
January 1936 . . . . .	103	92

2. *Study of the natural regeneration of valuable species in coupes where different intensities of opening were created by fellings in the past.*—Representative plots one square chain are laid out in all the coupes worked from 1919-20 to 1935 and an enumeration of regeneration was taken and recorded for future study.

The particulars of natural regeneration are as follows :—

	Average regeneration per acre.
(1) Six regeneration areas of 1919-20 . . . . .	924
(2) Coupes of 1926, 1927, 1928, 1929 and 1930 . . . . .	1,083
(3) Four coupes of 1935 . . . . .	1,416

3. *Best method of regenerating Bambusa polymorpha.*—In 1935 *kumri* at Makut the following methods were tried and the results are as follows :—

	Stakes.	Survival per cent.
Sowing . . . . .	60	12
Cutting . . . . .	60	7
Rhizomes . . . . .	25	28

4. *Artificial regeneration of Hopea parviflora under shade.*—Lines 3' wide were cleared 9' apart in forest and staking was done at 6' on the line. *Hopea* germinating seeds were notched at stakes. Out of 530 stakes planted 417 have plants and percentage of survival is 79.

5. *Sample trees.*—The girth measurements of trees were not recorded during the year, as the triennial measurements are due in the current year.

#### *Experimental Cardamom Male.*

During the year a departmental cardamom *male* was opened in Bhagamandla range, with a view to study the method of cardamom

cultivation to find out measures to keep off insect attack and to know the working expenses of *males*.

For this purpose a bit of 30 acres from a relinquished coffee *saguvahi male* was acquired for cultivation.

In this 40 old neglected plots were cleared and stocked with cardamom plants. Six new plots were opened and planted with cardamom. Two weedings were carried out during the year. A small nursery was opened to study germination and have a supply of plants for trying experiments.

The borer attack was seen in all the plots and the attack was seen in other *males* also. The damage from this was not very severe.

During the year we realised a revenue of Rs. 54 from the sale of cardamom and the expenditure for the year was Rs. 185-10-0.

## MADRAS.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General*.

1. In this brief report it is not possible to give full experimental data to support all statements made or opinions given nor does space permit mentioning all items of work undertaken. For fuller information the "Annual Report on Silvicultural Research in the Madras Presidency for the year 1935-36" published separately should be consulted.

2. A large proportion of the work done has been small scale stage I (a) experiments in Experimental Gardens and routine seed germination and weightment tests.

3. The most important results obtained during the year are probably :—

- (i) The successful control of the spike disease of sandal over large areas in the case of new outbreaks provided that they are reported and antispikes measures adopted without delay.
- (ii) Confirmation of the transmission by insects of the spike disease of sandal and demonstration of the fact that the disease thus induced under controlled conditions can be further transmitted by grafting (as is the case with natural spike).
- (iii) The successful control of *Lantana* at a reasonable cost by chemical spraying. A spray has been evolved which while killing out the *Lantana* does not usually affect other species growing among it.
- (v) The successful underplanting of dense *Lantana* with *Bambusa*. The hamhoo has grown right up through the *Lantana* without any attention and is killing out the pest.

- (v) The successful transport of teak stumps to distant places. Stumps have been sent journeys of 1,000 miles taking up to 14 days and in the majority of cases after 2 years the plants resulting from these stumps have been as good as and better than those from local stumps in spite of the fact that they were growing in localities climatically very different from that in which they were raised in the nursery.
- (vi) Demonstration of the benefits of soil working in the regeneration of dry fuel forest. Soil working resulted in 3 times as many seedlings surviving the hot weather.
- (vii) Confirmation by large scale experiments that in mixed deciduous forest of good quality, the beneficial effects (if any) of forking as a weeding method in teak plantations compared with *mamooty* scraping were in no way commensurate with the extra cost of forking.
- (viii) Further confirmation of the smallness of the risks run in premonsoon stump planting of teak in our better teak districts even in a year abnormally lacking in early rains. This has also been confirmed by large scale district work, the averaged results of which were within 2 per cent. of those obtained in small scale experiments.

(ii) *Climate.*

- 4. Rainfall statements are given in the full Annual Research report.

## II.—NATURAL REGENERATION.

### *By Seed.*

5. Experiments showed that clearing undergrowth under mother trees of *Swietenia macrophylla* in an attempt to produce profuse regeneration is definitely harmful.

6. Similar experiments with *Mesua ferrea*, *Calophyllum elatum* and *Hopea parviflora* showed that the treatment had produced no beneficial but no harmful effects.

7. Opening of the canopy over young regeneration was very beneficial in the case of *Hopea parviflora* but produced no noticeable effect on *Mesua ferrea*.

8. Complete removal of the canopy over *Swietenia macrophylla* regeneration 5' to 6' high produced a very beneficial effect and in the 2nd year since the treatment was applied there has been no increase in insect attack as was feared might be the case.

9. Partial canopy removal over dense regeneration of *Pterocarpus santalinus* about 3" to 6" high produced a very beneficial effect.

*By Coppice.*

10. Experiments in the dry fuel forests of Chittoor and the *Eucalyptus* plantations of the Nilgiris both showed that the ordinary operation of coppicing causes a mortality of approximately 5 per cent. of the stools and that the trimming of the stools was definitely harmful in dry forests.

## III.—SEED.

11. *Seed pretreatment*.—Routine pretreatment tests were done with 13 species. Treatment with boiling water improved the germinative capacity of *Acacia auriculiformis* and *Acacia cyanophylla* but was harmful for nearly all other species tried. Soaking in cold water was beneficial with *Calophyllum elatum*, *Gluta travancorica*, *Pterocarpus santalinus* and *Xylia xylocarpa*, being very marked in the case of the *Pterocarpus*. Concentrated sulphuric acid hastened and greatly improved the germination of *Cassia fistula* and *Cassia marginata*, while fermenting improved that of *Acacia auriculiformis*, *Acacia leucophlœa* and greatly improved that of *Terminalia chebula*.

12. *Seasonal collection*.—Tests made with 7 species showed no definite variations in germinative capacity throughout the fruiting season.

13. *Seed storage*.—Tests were done with 14 species to determine the longevity of seeds stored in different ways. Results are given in the Annual report.

14. *Seed weighments*.—Routine tests were carried out as usual. Results are given in the Annual report.

15. *Sorting seed by size*.—Work done during the year confirmed previous years' results that the sorting of teak seed by size is not justified economically.

16. Tests with seeds from small immature, normal mature, and large overmature seed bearers with several species showed no appreciable differences in germinative capacity or height growth of resulting seedlings.

17. *Seed origin*.—We have now 2 well established long term all-India teak seed origin plantations which are growing fast. Sample plots will be laid out in each origin when the first thinnings become due. In addition, some short term investigations were carried out during the year, the details of which are given in the Annual report.

## IV.—NURSERY WORK.

18. In hot dry fuel areas shaded nursery beds gave generally a higher germinative capacity with nearly all species tried, but in subsequent development and survival individual species exhibited different light requirements.

19. Experiments in evergreen nurseries on sheltering and shading in the case of species that suffer from the very heavy rain of the South-West monsoon and the hot sun which follows it showed that *Hopea parviflora* and *Cedrela toona* are indifferent to shade treatment, that *Artocarpus hirsuta* greatly benefits by the shelter but is indifferent to its extent and that *Dysoxylum malabaricum* needs a little shade but will not stand much.

20. Experiments have been started to demonstrate the effect of repeatedly using the same nursery beds for teak and to see whether the fertility of the beds can be maintained by various artificial means.

21. Work on different nursery methods for raising teak stumps indicates that the best outturn of good stumps is obtained by sowing seed at the rate of 20 to 30 lbs. per standard 40'  $\times$  4' bed and doing no pricking out of seedlings at all. A bed of this size in this way will produce after 1 year sufficient stumps of the right size to establish fully 1 acre of plantation at a 6'  $\times$  6' espacement and still leave a slight margin of safety.

## V.—ARTIFICIAL REGENERATION.

### (a) *Mixed deciduous timber forests.*

22. The stocking of felling gaps in mixed deciduous forest with teak is now extensively carried out and presents no difficulties in the initial stages. There is however some cause for apprehension in certain areas where climbers and *Lantana* are particularly aggressive, that the plants may be swamped by invasive growth in later years after tending has ceased. Experiments have been started to watch the fate of such gaps.

23. *Comparison of sowing, transplanting and stump planting.*—Previous years' results were confirmed and showed that for teak, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Artocarpus hirsuta*, stump planting is the best of the 3 methods, while for *Xylia xylocarpa* direct sowing is to be preferred. *Pterocarpus dalbergioides* and *Swietenia macrophylla* however both do best from transplanting.

24. *Optimum season for stump planting.*—Experiments were repeated with 5 species and confirmed previous years' results. Last year was the second consecutive bad year for early rains and in many places premonsoon showers were absent. In spite of this, however, premonsoon planting gave very fair results with a best date of April 15th to May 15th varying with the different species. The effect of the poor year was much more noticeable in the smaller height growth of teak than with other species. Teak stumps tended to sprout much later and the best date for species other than teak was about a fortnight later than usual.

25. *Stump planting*.—*Effect of diameter of stumps*.—Teak stumps of 0.4" to 0.8" diameter at the thickest part gave the best results, though stumps of 0.3" to 0.4" diameter are definitely "usable" in the event of shortage of the larger stumps though they do not give as good results.

26. In the case of *Dalbergia latifolia*, 0.2" to 0.6" diameter is the best range. For *Pterocarpus marsupium* results indicate that the larger stumps from 0.3" to 0.8" diameter (or even bigger) give the best results. For *Terminalia crenulata* 0.4" to 0.8" diameter appear best and for *Artocarpus hirsuta* those of 0.4" to 0.6" diameter.

27. *Stump planting*—*effect of length of root*. *Teak*.—Repetition of previous years' work confirms the indication that there is practically no difference in results from stumps of different root lengths within the range 4" to 10".

28. *Stump planting*—*effect of cooly variation*. *Teak*.—Experiments were done in which stumps were planted tightly by expert planting coolies, intentionally loose, nipped at the top with the hase loose in the crowbar hole, and by a blacksmith and a farmer who were given no instructions at all. There was no appreciable difference at all in the results of these treatments in percentage of survivals or in mean height growth.

29. *Storage of stumps*. *Teak*.—Experiments showed that stumps can be successfully stored for two weeks before planting even in an abnormally bad year.

30. *Transport of stumps*. *Teak*.—Stumps were successfully transported over distances up to 1,000 miles taking up to 14 days for the journey and after 2 years were giving as good as and better results than local stumps.

31. *Stump planting in swampy areas*. *Terminalia crenulata* and *Pterocarpus marsupium* were successfully stump planted in a swampy area where mound regeneration work had failed for some years.

32. *Casualty replacements in 2nd year teak plantations*.—Further experiments to watch the fate of casualties replaced with stumps in the 2nd year of teak plantations were started. Results so far indicate that few of these replacements survive and it is doubtful if they ever take their place in the main crop.

33. *Effect of taungya (ponam) crops on teak plantations*.—An experiment was continued in which it was attempted to counteract the retarding effect of a *taungya* crop in the 1st year of a teak plantation by growing cover crops such as sunn hemp (*Crotalaria juncea*) and boga (*Tephrosia candida*) in the 2nd year. In general these cover crops appeared to produce no marked improvement in the retarded teak. This retarding effect of the *taungya* crop can however be greatly minimized by early planting the teak.

(b) *Evergreen Rain Forests.*

34. All artificial regeneration work in evergreen forests (with the exception of one experiment on raising evergreens after clear felling and burning, with and without cover crops) comes under the category of underplanting and is therefore dealt with under that head.

(c) *Dry Fuel Forests.*

35. Artificial regeneration of dry fuel forests by the 'rab' method is being done on a larger scale each year in almost all divisions where this type of forest occurs and results are getting more and more encouraging as the technique improves.

A detailed description of the methods adopted in districts which have so far been most successful will be found in the full Research Administration report. It is however too long to be given in this brief report.

36. In general results indicate that (1) artificial regeneration by any method is best done at the beginning of the North-East monsoon except in especially good years or when watering is possible. (2) With most species the best method of regeneration is sowing in a good year but transplanting in a bad year. When seed is plentiful and repeated sowing can be done, good results can be obtained under almost any weather conditions. (3) Stump planting is not a suitable method for most species in this type of forest. (4) The following species have given excellent results:—*Cassia siamea*, *Albizia lebbek*, *Azadirachta indica*, *Dolichandrone crispera*, *Acacia sundra*, *Albizia odoratissima*, *Pterocarpus santalinus*, *Albizia amara*, *Wrightia tinctoria*, *Zizyphus jujuba*, *Pithecolobium dulce*, *Acacia ferruginea*, *Prosopis juliflora* and *Tamarindus indica*.

37. A good burn coupled with soil preparation is essential for this work.

38. Soil working during the 1st year is very beneficial. It has been shown to give an increased height growth and also it enables backward plants to survive the hot weather.

39. Stump planting of *Santalum album* has given a large measure of success.

(vi) *Afforestation.*

40. Experiments to examine the possibility of re-afforesting some of the important catchment areas of the Nilgiris were continued. Much better results were obtained this year with transplants and stumps of these species that can be regenerated by these methods. Results so far show that for nurse species Broom, *Cassia tomentosa*, *Rubus moluccanus*, and *Hypericum mysorense* and for tree species *Acacia melanoxylon*,

*Acacia dealbata*, *Mahonia leschenaultii*, *Hakea saligna*, *Eugenia arnottiana* and *Cupressus macrocarpa* all show promise.

In addition to the above, on stream banks and swamp edges *Salix alba* var. *cærulea*, *Salix tetrasperma*, and *Salix babylonica* have all been established and appear to be doing well.

(vii) *Tending, Thinning, Cleaning, etc.*

41. *Weeding practice*.—Large scale experiments were done in continuation of the many small scale experiments carried out in recent years. These large scale experiments conclusively confirmed previous years' results that the slightly beneficial effect (if any) of forking as opposed to *mamooty* scraping as a weeding method in the 1st year of a teak plantation in our better teak areas is in no way commensurate with the extra cost of forking. The saving by *mamooty* weeding instead of forking is approximately Rs. 3 to 5 per acre each time the operation is done and when this is totalled for the main teak districts of the presidency it is an annual saving of a very considerable sum of money.

42. These experiments were all done in areas with a naturally light friable soil and a rainfall of 60"—120" per annum. The effect of forking in dry fuel forests has already been noted in para. 38 above.

43. *Effect of burning and cutting back a teak plantation in the 2nd year*.—Experiments in this subject were repeated and confirmed previous years' results that cutting back with burning gives slightly better results than cutting back without burning but neither of these treatments are as good as the control. The indications are that plantations should not be treated in this way but if cutting back becomes essential due to some calamity it is better to burn before doing the operation.

44. *Effect of a cover crop of Leucæna glauca on a teak plantation*.—An experiment in this subject showed that the teak height growth was apparently increased by the presence of the cover crop. Immediately after measurements were taken the plot was visited by bison and the *Leucæna* browsed right down to the ground level. It remains to be seen whether the improvement in the teak is maintained in the 2nd year.

45. *Thinning Research*.—Teak. We have now sets of plots in this work as follows :—

*Nilambur*.—(A) Best date of 1st thinning.

(B) Best intensity of thinning.

(C) Best periodicity of thinning.

*Begur*.— (A) Best date of 1st thinning.

(B) Best intensity of thinning.

In addition, a set of plots has been laid out at Nilambur to see whether Dr. Craib's theory that thinning should precede suppression and not follow it, is applicable to teak. The treated plots were first thinned in the second year with a 50 per cent. mechanical thinning. In these plots suppression will not be allowed to occur while the control plots will be thinned according to normal district practice.

46. *Effect of burning a Eucalyptus globulus fuel plantation after coppicing.*—An experiment in this subject showed that the operation was not beneficial in any way.

#### (viii) *Mixtures.*

Nil.

#### (ix) *Underplanting.*

47. (a) *Teak plantations.*—Experiments so far show that teak plantations can be successfully underplanted with *Bambusa arundinacea*, *Cephalostachyum pergracile* and *Hopea parviflora*. *Swietenia macrophylla* and *Cedrela toona* although established are continually browsed.

48. (b) *Evergreen rain forests.*—The general results of experiments of last year in underplanting in evergreen rain forest show that :—

- (1) Top canopy cover gives the best results.
- (2) Burning before regeneration produces no beneficial results.
- (3) For most species transplanting is the best method of regeneration.
- (4) Stump planting is not a suitable method for most evergreens (with the exception of *Cedrela toona*, *Chikrassia tabularis* and *Artocarpus hirsuta*).
- (5) Weeding is worthwhile as it gives a slight gain in height growth and survival percentage.
- (6) Pitting for planting is also similarly worth while although the effects of pitting do not show markedly until the 2nd year when the roots have got bigger.
- (7) For most species, July or early August appear to be the best months for transplanting or perhaps rather earlier for areas of light rainfall 60"—80" and rather later for areas of heavy South West monsoon rainfall 120"—250".
- (8) For most species the best size of transplants to use is from 8" to 1' high. Larger transplants occasionally do well but suffer heavy casualties and are not definitely established for several years. In the case of large transplants of *Cedrela*

*toona* and *Swietenia macrophylla* insect attack is much more serious than with small plants.

- (9) There is little difference in results between nursery and natural forest transplants.
- (10) Basketing has proved very successful with *Dipterocarpus indicus*.
- (11) *Cedrela toona* has been successfully regenerated by cuttings.
- (12) Repulsive smears do not decrease the browsing incidence.

(xi) *Miscellaneous.*

49. *Spike Disease Research.*—The following are the chief results of the year's investigations :—

- (1) Confirmation of the transmission of spike by insects has been definitely established in mass infection cages.
- (2) The night fauna appears to be generally responsible for transmission but indications are that the day fauna cannot be totally ignored.
- (3) The infective seasons are chiefly March to May and August to October.
- (4) The general classification of insects through which transmission was established indicate that the insect vector is probably of one of the families *Jassidae*, *Pentatomidae* and *Fulgoridae*. Group and specific transmission experiments are in progress.
- (5) Experiments were carried out to find the chief food plants of the main suspects.
- (6) The susceptibility or resistance of an area to the diseases appears to be greatly influenced by the ecological make up of the area.
- (7) Further evidence was obtained that new outbreaks often occur in close proximity to diseased field crops.
- (8) Artificial infection by grafting and natural infection in the field are comparable.
- (9) Anti-spike measures in the case of new outbreaks have been successfully applied. In none of the areas treated has there been any recrudescence of the disease so far.

50. *Periodicity of height growth.*—Weekly measurements showed that the period of rest with most species in most centres started in November-December and ended towards the end of April.

## Weeds.

51. *Lantana eradication*.—Experiments in the suppression of *Lantana* by underplanting it with *Bambusa arundinacea* continue to look very promising.

52. A sodium chlorate spray has been evolved which while successfully killing out the *Lantana* at a reasonable cost does not usually affect other species growing in the *Lantana*.

53. *Climber poisoning*.—Experiments were continued and show that most of the common species of climbers can be successfully eradicated by an arsenical poison at a reasonable cost.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans*.

54. Five Working Plans were under compilation at the beginning of the year of which three were completed during the year. Three new plans were started during the year.

55. The cost of preparation inclusive of establishment was Rs. 0-2-6 per acre.

(ii) *Yield, Volume and Form Factor Tables*.

56. Seventy eight sample plots, 27 Tree Increment plots and 12 Preservation plots were maintained during the year.

## III.—MISCELLANEOUS.

(i) *Tours*.

57. The Provincial Silviculturist was only able to do a minimum of touring owing to lack of staff.

58. Opportunity was taken while *en route* to South Kanara to visit the research experiments conducted in Coorg in accordance with the orders of Government to co-operate with the Chief Forest Officer, Coorg, in the conduct of such experiments.

59. All the research range offices of the division were inspected during the year.

(ii) *Records*.

60. The Specific and General Ledger files now number 418 and 149 respectively.

61. Twenty seven new Experimental Plots and 116 new Experimental Garden experiments were opened during the year while 80 Experimental

Plots and 293 Experimental Garden experiments were summarised and closed during the year. At the end of the year 72 Experimental Plots and 145 Experimental Garden experiments were open.

62. Two hundred and twelve photographs were added to the collection during the year.

### Staff.

63. The Extra Assistant Conservator of Forests remained in the division throughout the year as assistant. The subordinate staff now consists of 3 Research Rangers, 8 Foresters and 1 Forest Guard.

64. The office staff of 2 clerks and 1 typist was increased during the year by the sanction of 1 more clerk. A substantial reduction in the arrears of office work was made during the year.

## NORTH-WEST FRONTIER PROVINCE.

### I.—EXPERIMENTAL SILVICULTURE.

#### (iii) *Seed Supply.*

1935 was a very good seed year for deodar in the Kagan Valley.

#### (v) *Artificial Regeneration.*

*Cedrus deodara*.—The experiment, described in last year's report, under which 3,000 deodar transplants were put out during the winter (1934-35) has not proved very successful. The plants were apparently not strong enough to withstand the spring drought (May-June). Monsoon planting must now be considered the better transplanting season.

*Fraxinus excelsior*.—Cuttings of ash, made from nursery plants and put out in the monsoon, are proving very successful in the Kagan valley. It has been noticed that cuttings  $\frac{1}{2}$ " to 1" thick do better than those below  $\frac{1}{2}$ ".

*Prosopis juliflora*.—Mesquite sowings in the low hill (3,000') olive forests of Khanpur have been a complete failure. The cause of failure is uncertain: it may be that these dry limestone hills are not suited to the species or they may have been damaged by hares.

*Ailanthus glandulosa*.—This species is doing very well at lower elevations in the Galis division, and is particularly useful for filling up landslips. Cuttings  $3\frac{1}{2}$ ' in length, with 2' buried in the ground, have done well and much better than the  $1\frac{1}{2}$ ' cuttings. They can survive dry periods much better.

*Nannorrhops ritchieana*.—In the Kohat district sowings of the seed of the dwarf palm made on berms of irrigation trenches in March were

successful, germination being complete by the end of June. Sowings made on unirrigated land failed completely and so did all the off-sets.

(vi) *Reclamation and Afforestation.*

*Afforestation in water logged kallar areas.*—All attempts made during the last 4 years in the Peshawar district to get trees to grow on water logged areas both with and without the aid of irrigation have failed. The species tried were stumps of sissoo and mulberry, shoot cuttings of *farash* (*Tamarix articulata*), willow (*Salix babylonica* and *S. tetrasperma*), *chinar* (*Platanus orientalis*), *bakain* (*Melia azedarach*), *Eucalyptus rostrata*, *E. rudis*, *E. kirtiniana*. In unirrigated areas the planting was a failure and in irrigated areas only a few plants of *sissoo* and *Eucalyptus rostrata* survived near water channels, where the *kallar* had evidently been washed out. But after they had reached a height of 10 feet they stopped growing and began to dry up. The experiment has now been abandoned.

Experiments are in progress to find a frost resistant species of *Eucalyptus* which will grow at Parachinar 5,800' elevation. The following species have been tried :—

*E. crebra*, *globulus*, *maideni*, *nelliadora*, *eximia*, *sideroxylon*, *rostrata*, *siderophloia*, *carynocalyx*, *saligna*. The plants were raised in bottomless pots and planted out when 1½ year old. Of the species tried, *Eucalyptus globulus* and *crebra* survived the snow hest. The experiment is being continued.

(xi) *Miscellaneous.*

*Digitalis purpurea*, introduced in the Lower Kagan in 1934 from Kashmir seed, is now established. Leaves were sent for test to Calcutta and found to be up to standard. A quotation for Rs. 55 per maund of dried leaves f.o.r. Havelian has been arranged.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

Mr. H. L. Wright's revised working plan for the Lower Siran and Agror forests has been introduced. The yield of the Regular Circle is calculated on a complete enumeration of all the forests in the Circle, and the forests allotted to the regeneration block form 37.44 per cent. of the working plan area.

(ii) *Volume Tables.*

In the Kagan valley 11 deodar and 41 blue pine trees were carefully measured for commercial volumes, and 9 deodar and 30 blue pine for volume and outturn. Data collected were sent to the Silvicultural Research division, Lahore.

## III.—MISCELLANEOUS.

Photos to show denudation and erosion were taken and 12 negatives sent to the Silviculturist, Forest Research Institute, Dehra Dun.

## PUNJAB.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

*Forest soils.*—Indian Forest Record, Volume I, No. 2, (1936) "A Study of the Soils in the Hill Areas of the Kulu Forest division, Punjab"—Part I, was issued as a joint publication of the Irrigation Research Institute, and Silvicultural Research division. Part II of the series was completed and is in the press.

*Propagation of Prosopis juliflora.*—Work on propagation of *Prosopis juliflora* in the Punjab plains was continued and extended in the Research division.

Nine maunds and 18 seers of pods were harvested. Of this quantity about 2 maunds were supplied to the railways, and the balance distributed among forest divisions. In addition 15,820 seedlings were raised in pots, and pot plants supplied to the railways for extended planting in the Delhi, Ferozepur, Lahore and Multan divisions.

(ii) *Natural Regeneration.*

*Abies pindrow.*—In the Research division a new experiment was started in Pulga, Parhatti range, for studying the success of natural seedlings on mineral soil exposed in strips. Removal of humus in strips was considered the most promising method of dealing practically with large fir areas. In the experiment humus was scraped in 10 feet wide and 100 feet long strips laid out obliquely to the contours. Seed was sown broadcast in the strips, owing to deficiency of seed on old trees.

In the old experimental plots, little progress was recorded in natural regeneration owing to the poor seed year. In experimental plot 16, laid out for studying success of natural regeneration under strips of different widths, seedling success was greater in 75' strips than in 50' or 100' strips, and also greater with humus removed than with humus left intact or mixed with soil. Observations in gap regeneration in selection type of crop indicated the same conclusion.

In experiments in the Kulu division with clear-felled strips, a north-south direction was found more favourable for the establishment of natural regeneration than an east-west direction. Natural seedlings were comparatively numerous in the former type of strips. Scraping

the humus and weedings were advantageons. In experiments with clear-felled and wooded strips, conditions for natural regeneration under the former were definitely unfavourable.

*Dendrocalamus strictus*.—Apart from natural influences, proper silvicultural treatment of individual clumps was an important factor affecting the number and vigour of new shoots produced. In experiments in Bindrahan and Karnpur forests, with completely, partially worked, and unworked clumps, the percentages of new shoots produced were 40, 19 and 7 respectively.

*Morus alba*.—At Changa Manga, in experiments with the disposal of felling refuse, hurning the dehris was found advantageous. Under unhurnt refuse, which did not decay during winter, growth of natural seedlings of mulberry was retarded, hut weed growth was quite unaffected. Weeding stimulated the development of seedlings, but with coppice, growth was more vigorous, the denser the weeds, indicating contrary behaviour.

### (iii) Investigations on Seeds.

(a) *Seed year*.—In the hill divisions, the seed year was poor for all the coniferous species. In the plains *shisham* (*Dalbergia sissoo*), *kikar* (*Acacia arabica*), *tut* (*Morus alba*), *bakain* (*Melia azedarach*) and *Prosopis glandulosa* seeded profusely.

(b) *Seed weighments*.—In the Research division, seed weighments were recorded at Lahore for 7 species including all forms of *Prosopis juliflora*, and at Manali for 38 species including some exotic conifers.

(c) *Germination tests*.—In seasonal sowing experiments in research nurseries at Manali with exotic pines, good germination results were obtained with seed sown in spring, and with other species in winter. *Larix europæa* and *Castanea sativa* gave poor germination in all seasons.

With deodar seeds collected from mature trees, crown classes did not have any influence on germination or seedling development.

In germination tests with seeds from different altitudes, best results were obtained for *Pinus excelsa* with seed from 4,000—5,000 feet elevation, and for *Abies pindrow* from 8,000' elevation.

With *Picea morinda*, germination was not found to be correlated with elevation, though better results were indicated with seed from about 7,000' elevation.

*Fraxinus excelsior* seed treated in cold water for 48, 72, 96 and 120 hours, as well as in hot water at 120—200° F, allowing the water to cool off after seed immersion, failed to germinate. The same results were obtained with seed hatched in hot water vapour for 3—12 hours. Seed buried in hot ashes did not germinate.

(iv) *Investigations on Seedlings.*

(a) *Seasonal height growth.*—Seasonal height measurements were recorded for seedlings of important species grown in the research gardens.

(b) *Frost injury.*—Observations on typical form and intensity of frost injury were continued with species grown in research nurseries and under plantation conditions. The results are summarised below :—

*Fully hardy or resistant to frost injury.*—*Acacia giraffæ*, *A. greggii*, *Artemisia maritima*, *Atriplex canescens*, *Eucalyptus melanophloia*, *E. rostrata*, *E. rudis*, *Fouquieria splendens*, *Monothea buxifolia*, *Pistacia chinensis*, *Prosopis juliflora* (Argentine form), *P. nigra*, *Schinus molle* and *Sophora secundiflora*.

*Hardy, i.e., with injury confined to growing points or tender leaves.*—*Anogeissus pendula*, *Celtis eriocarpa*, *Chilopsis linearis*, *Diospyros cordifolia*, *Enterolobium timbouva*, *Eucalyptus citriodora*, *Maclura aurantiaca*, *Parkinsonia microphylla*, *Prosopis juliflora* (arid and Mexican forms), *P. pubescens*, *P. strombocarpa*, *Tipuana speciosa* and *Sterculia diversifolia*.

*Half-hardy i.e., with die-back of shoots extending to previous year's growth.*—*Leucaena pulverulenta*, *Prosopis juliflora* (Texas).

*Frost tender, i.e., die-back extending to the whole of above-ground part of plants, but growth breaking forth again from the lowest point unaffected by frost.*—*Acacia arabica* (C. P. Kauria variety) and *Bauhinia racemosa*. The above classification is based on observations made chiefly in Chichawatni. *Prosopis* seedlings showed strong individual traits as regards frost resistance, particularly the Australian form.

(v) *Investigations on Trees and Crops.*

(a) *Phenological studies.*—In the Research division, phenological observations were recorded for *Pithecolobium dulce*, *Prosopis juliflora*, *Acacia arabica*, *Albizia lebbek*, *Dalbergia sissoo*, *Maclura aurantiaca* and *Melia azadirachta*.

(b) *Water requirements of shisham crops.*—Depth of irrigation experiments in Chichawatni to determine the water requirements of *shisham* crop continued from past 5 years were closed. Analysis of results based on height measurements taken in various sub-plots with different irrigation treatments showed that 4' depth was about the optimum limit of water requirements for young *shisham* crops in Chichawatni conditions. With 6" irrigations, average height growth was better than with 3" irrigations (strictly shallow irrigation).

(c) *Inheritance of racial or individual character of trees.*—*Dalbergia sissoo*.—To test the inheritance of the stem habit of *Dalbergia sissoo* as

regards repeated forking, two experimental plots were laid out in Chichawatni. In one, plants were raised by seed collected separately from trees with pronouncedly straight, crooked and very crooked stems, and in the other, by root-shoot cuttings taken from surplus seedlings progeny available from the first plot.

(d) *Succession in burnt areas.*—Lower Bashahr division.—Collection of plants in burnt areas was continued. According to visual observations bushes and low woody vegetation were becoming prominent.

(vi) *Artificial Regeneration.*

*Conifers.* *Abiespindrow.*—In research plots in Manalgahr, Pulga and Hathipur, much success was recorded during the first year with nearly 3-year old seedlings planted in August after carefully removing all humus from sites of pits. Over 80 per cent. of these were established. Tube planting with similar seedlings was equally successful. The behaviour of plants during the second year was uncertain, but hopeful.

In Kulu division, 5,000 2-year old transplants gave 50 per cent. success. Mortality among plants was in part due to trampling by cattle which grazed in the area.

*Cedrus deodara.*—In Kulu division, planting operations were carried out on a very large scale in which over 2,44,000 seedlings were handled. Of these, the bulk of seedlings were of deodar, which were successful.

In Pandrabis, Upper Bashahr division, better results were obtained with sowings carried out after scraping snow than with sowings before the snowfall.

In experiments for stocking difficult areas in the dry zone, on southern slopes carrying scanty tree growth, sowings carried out in the shelter of stones placed in the centre of patches to conserve soil moisture, after stubbing out grasses, gave little success.

*Cryptomeria japonica.*—In Kangra division, experiments with planting were continued in the Banoi reserve. Success varied from 60-90 per cent. in different areas.

*Larix europæa.*—In research plots in Hathipur, Kangni and Nakas 70-90 per cent. success was obtained with seedlings transplanted with naked roots.

In the Seraj division, of 51 plants supplied from the Manali nurseries 35 were established, giving 71 per cent. success.

*Larix leptolepis.*—In the research plot in Manalgahr, tube planting gave about 90 per cent. success during the first year.

*Picea morinda.*—With 2-year old seedlings, transplanted in research plots in Manalgahr, 90 per cent. success was obtained, their behaviour during the second year is as yet uncertain.

*Pinus longifolia*.—With tube planting in Bijuri, Hoshiarpur division, 38 per cent. success was obtained.

*Pinus tæda*.—In the research plot in Rahni, about 85 per cent. of plants survived during the first year, the growth was vigorous. In Banoi reserve, success with seedlings sent from the Manali nurseries was 52 per cent. and the surviving seedlings looked very healthy.

*Pseudotsuga taxifolia*.—Very variable results were obtained in the research plots in Kulu with this species in different areas; the results were on the whole quite unsatisfactory. In Kangni, 55 per cent. seedlings survived but looked very unpromising. In Manalgahr only 6 out of 120 plants survived.

*Thuja plicata*.—In research plots in Manalgahr and Kangni, over 85 per cent. success was recorded during the first year with tube planting of 12-16 months old seedlings. Both naked root and tube planting gave the same amount of success in Hathipur. The species is the best adapted for transplanting among the exotics tested in the Research division and most suitable for large scale cultivation in the fir zone.

In the Banoi reserve, 40 out of 50 seedlings sent from Manali were established, giving 80 per cent. success.

Seedlings from Manali were well established in Charithatch, but were unsatisfactory in Dunkramuil in the Kulu division.

The growth of this species will need to be watched for several years before experimenting with it on anything but a small scale.

#### *Broad-leaved species.*

*Acacia senegal*.—In experiments carried out at Sambalpani for testing the value of different species for introduction in areas now sparsely stocked with *Olea cuspidata* and *Acacia modesta* best results were obtained with *Acacia senegal* (sowings) and next best with *Prosopis juliflora* (pot-planting). However comparison as between these species could not be taken as fair owing to late and unseasonable planting of *Prosopis juliflora*. The results were considered heavily weighted against the latter species.

*Anogeissus pendula*.—Success with the establishment of *Anogeissus pendula* for stocking hillsides in Sambalpani on an experimental scale was very encouraging, but seedlings proved slow growers.

*Azadirachta indica*.—With trenches dug within a radius of 1 chain from parent trees, abundant crop of root suckers was obtained in the Phillaur plantation.

*Cedrela toona*.—With entire transplanting, 66 per cent. seedlings were established in *chil* forests in the Hoshiarpur division. The species was found useful for stocking areas unsuitable for *chil*,

*Cratogeomys religiosus*.—In the research plot at Dhamtal, with sowing in patches, germination was 25 per cent., commencing after ten days; seedlings died during the winter.

*Dalbergia sissoo*.—In experiments with trenching to induce the production of root suckers in the Phillaur plantation, an abundant crop of root suckers was obtained in 1'×1' trenches dug within a radius of 1 chain from large trees. This method was used with success for increasing the proportion of *shisham* in mixed crops, and keeping check on the spread of mulberry which does not sucker naturally.

With trenching following clear felling, 5 acres in Bela Shahjowal were completely stocked with root sucker crop.

In extensive trials with cuttings taken from root-suckers and planted in Arafwala and Dipalpur plantations, 60-80 per cent. success was obtained. These cuttings were characteristically T-shaped owing to the growth of the parent root in a horizontal direction.

In experiments for stocking difficult *dab* grass areas, success in early closing of canopy within three years was obtained in Arafwala and Dipalpur plantations with space between trenches reduced to 5 feet. The increased costs on irrigation are still under investigation.

*MacLura aurantiaca*.—In Chhanga Manga experiments with introducing Osage orange under open *shisham* crop were continued. Owing to browsing the growth of plants was, however, not satisfactory.

*Melia azedarach*.—In Chichawatni, trials with naked-root planting and root-shoot cuttings for stocking blanks with this species were most successful. The species was the best suited for this purpose on all soils except *rapper* soil. It was no use for original planting.

In Khanewal, success with entire planting in difficult areas, with thick growth of *dab* grass was 95 per cent. despite late planting operations, which were carried out in August.

*Millingtonia hortensis*.—In the research plot at Dhamtal, 92 per cent. success was recorded with ball planting.

*Populus ciliata*.—Branch cuttings planted in winter in experimental plots in Kangni and Hathipur and Sholtu gave promising results during the first year.

*Prosopis juliflora*.—In Montgomery division, Mexican and arid forms proved useful for restocking difficult areas subject to severe frost and on *rapper* soil where *shisham* had failed.

In Tehra plantation near Lahore vigorous growth of plants raised from seed, and cuttings planted in blanks showed the suitability of this species for filling such blanks. It is necessary to use only hardy forms, as seedlings of Australian form were badly frozen.

In Kot Lakhpat and Daphar, sowings failed for want of watering during the dry winter months. Winter irrigation was necessary in Shahdara where sowings were carried out along boundary lines. In the Ravi park, *Prosopis juliflora* of Texan and Peruvian forms did well.

*Rhus lancea*.—In areas overrun with *dab* grass in Khanewal this species proved more promising than any others tried.

#### (vii) Nursery Work.

At Chichawatni a new research nursery was started and the old one abandoned. The major portion of this nursery was divided into blocks devoted to the cultivation of species likely to be useful in the Punjab under arid conditions. *Prosopis juliflora* blocks were completed with plants of different forms. In the *Eucalyptus* blocks, much damage was done by white ants among *E. citriodora*, and *E. melanophloia* plants.

At Manali, Nurpur, Dhamtal and Sambalpani, existing research nurseries were maintained. Research was devoted in these nurseries to methods of raising and handling different species for working out standardised technique for practical use in divisions. In the Manali nursery, work was concentrated on hill species including a number of exotio conifers, in Sambalpani on arid-country species, in Nurpur mainly on succulents, and in Dhamtal on species to improve broad-leaf scrub fuel coupes. The existing pinetum at Manali was extended and stocking completed in separate blocks with *Thuja plicata*, *Pseudotsuga taxifolia*, *Chamaecyparis obtusa*, *Pinus patula*, *Pinus taeda* and *Pinus laricio*.

A new nursery was started in the compound of the Divisional Office at Dharmasala and devoted to the cultivation of exotics and other species suitable for planting in the Benoi reserve or other areas near Dharmasala.

Two nurseries were maintained in Bindra Ban in Hoshiarpur division. Besides *Dendrocalamus strictus*, the species handled in these included *Eugenia jambolana*, *Azadirachta indica*, *Prosopis juliflora*, *Butea frondosa*, *Albizzia lebbek*, *Tectona grandis*, and *Dalbergia sissoo*.

In the Khanewal nurseries, the usual method of making beds was improved by making parallel ridges. Ridging was advantageous for inducing vigorous roots and in pulling out seedlings and watering.

The results of some of the experiments carried out in the research as well as in divisional nurseries are summarised below by species:—

*Conifers*—*Cedrus deodara*.—In weeding experiments, two weedings at the end of May and July gave better results than one weeding as regards average height of seedlings, but three weedings were not better than two weedings.

*Picea morinda*.—In the humus experiments in Manali very poor germination took place on beds covered with humus layer, irrespective of

thickness or the type of humus used whether raw, half-decomposed or fully decomposed. Seeds sown on beds without humus covering gave 50-60 per cent. germination and 20-30 per cent. survival.

### *Broad-leaved species.*

*Aesculus indica*.—With root-shoot cuttings, best results were obtained with  $\frac{1}{2}$ "-1" thick cuttings planted in early spring, giving 96 per cent. success. Thin cuttings under  $\frac{1}{2}$ " in diameter planted during rains also rooted well, the success being 83 per cent.

*Juglans regia*.—80 per cent. of root-shoot cuttings planted in winter struck vigorously in the research nurseries at Manali.

*Populus ciliata*.—In the research nurseries at Manali, thin root-shoot cuttings under  $\frac{1}{2}$ " diameter, planted in winter gave 49 per cent. success. Sprouting was good with spring planting, but the cuttings did not strike well.

*Exotic poplars*.—At Lahore, cuttings of poplar species *P. serotina*, *P. marylandica*, *P. carrieriana*, *P. regenerata*, and *P. eugenii* received from Kew were started in 12" pots. Out of 118 cuttings 25 struck, *P. eugenii* gave the best results, *P. regenerata* and *P. marylandica* next best, while sprouting was very late and striking poor with *P. serotina*.

Successful cuttings were sent to Manali for raising a small plantation to provide cuttings for trial in the fir zone, and other suitable places.

*Prosopis juliflora*.—In the Research nursery at Samhalpani, with sowings of arid and Mexican forms, success was over 80 per cent.; seedlings of arid forms were, however, the more vigorous growers.

With root-shoot cuttings behaviour of various forms as regards vigour of rooting and development showed appreciable differences. Argentine and Mexican forms gave the best and worst results, with striking percentages of 75 and 25 respectively. Australian and arid forms gave results intermediate between these two with 50-60 per cent. survivals.

### <sup>1</sup>(viii) *Reclamation and Afforestation.*

*Counter-erosion planting*.—In the erosion demonstration area at Nurpur, much success was obtained with *Ala vera*, *Opuntia* and *Agave* species planted in active landslips, eroded slopes and at the head of ravines. The species of *Opuntia* used were *dillenii*, *monacantha* and *stricta*, and of *Agave*, *cantala americana* and *wightii*; of these *Opuntia dillenii*, and *Agave americana* gave the best results.

(ix) *Thinnings and Cleanings.*

Thinnings were carried out in the research experimental plot at Chichawatni in various sub-plots with *shisham* crops started with different espacements. Comparative results will become available in time.

## II.—STATISTICAL RESEARCH.

(a) *Yield Statistics.*

*Bamboo felling cycle plots.*—In the all-India co-operative bamboo plots in Hoshiarpur division, measurements were taken and fellings were carried out in clumps worked under 2-year felling cycle.

*Sample plots.*—No new sample plots were laid out during the year; two plots were clear felled in the Montgomery division. The total number of permanent plots was 169 and of temporary plots 71.

All plots in Upper Bashahr and all but five in Lower Bashahr division were measured by Central Silviculturist who toured with a party in these divisions. 4 plots in the Hoshiarpur division, and 8 plots in the Lahore division were measured by the provincial research parties. All sample plots were in good condition.

(b) *Tree Statistics.*

The number of standard and commercial measurements on the permanent records to date was 7,240 and 2,678 respectively.

142 standard and commercial measurements on kail and deodar trees were added during the year.

## III.—MISCELLANEOUS.

(i) *Rainfall statistics—Research division.*—Rainfall statistics were maintained and consolidated annual statement was compiled.

(ii) *Photographic collection.*—Indexing and filing of photographs of forest interest was continued. 60 prints were added during the year including 30 aerial photographs of the Siwaliks taken by Mr. H.M. Glover which were of unusual interest. The total collection as it stood at the end of the year was 1,485 prints.

(iii) *Records.*—13 specific and 14 general ledger files were newly opened, bringing their total number to 142 and 325 respectively.

(iv) *Library.*—In the Punjab Forest Library three new almirahs for books were added to provide room for expansion in the number of volumes maintained. 103 new books were received, in addition to serial bulletins and other periodic literature.

(v) *Working Plans.*—Six working plans were completed while three working plans and one working scheme were under preparation during the year.

## UNITED PROVINCES.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

*Sal* natural regeneration is still the most important experimental problem. Further linear increment plots were laid out in addition to the routine sample plot work.

2. The number of sanctioned experiments under the Silviculturist decreased from 66 to 56.

3. The number of divisional experiments was reported to be 32 at the close of the year.

(ii) *Natural Regeneration.*(a) *From seed.*

4. *Shorea robusta* (*sal*).—The more work is done, the less easy does it seem to lay down rules for *sal* natural regeneration. On a small scale in several plots it is proved that natural seedlings if weeded during the rains will come straight up provided they are protected from browsing and given sufficient light. This work is now being repeated by the Western circle on a large scale to see if it is economically practicable.

5. Two articles one by Mr. Smythies in the April *Indian Forester*, and one by Mr. Mobbs, to appear in August, summarise the present position.

6. It is difficult to say very much at present, for what may be perfectly correct in one place may be wrong or unnecessary in another. For example deerproof fencing, which is absolutely essential in practically every area experimented on, would obviously be unnecessary where there were no deer, and was in fact unnecessary at Majhola in Haldwani.

7. In good Bhabar type *sal* (Champion's B. 3) if whippy or woody seedlings are present in *sufficient quantity* (I am not attempting to define these terms here), then plenty of overhead light, protection from browsing (deer proof fence), and protection from weed competition (shrub cutting) will let the seedlings grow straight up and become small saplings in about five years. But there are pitfalls. If the whippy seedlings are very small and the overhead light excessive then weed competition, grass largely, may cause failure—certainly it would necessitate shrub cutting in the rains, not in the cold weather. Still despite pitfalls, we do consider that given an area with an adequate number of whippy seedlings in Bhabar *sal*, we can guarantee its natural regeneration. This

is being done by several divisional forest officers both experimentally and on a large scale.

8. There remains the problem of filling the area with these whippy shoots. The experiments are not complete but it has been done once. It appears that undergrowth must first be made favourable (opening and burning in evergreen and so on). Then (or before) the canopy must be reduced to about sixty per cent. stocking of mature seed bearers. With too much light at this stage weeds, especially grass, will become so rampant that the area will fail. With too little light the seedlings cannot develop. The area must be deerproof fenced and when the seedlings appear they will need shrub cutting during the rains. The above is not entirely theory but will not be correct everywhere, the light for instance must be varied with the type.

The Silviculturist has now completed the series of plots in the various *sal* types from which it is hoped to confirm or modify our present ideas.

#### (b) From coppice.

9. *Acacia arabica* (babul).—Mortality of *babul* coppice in Etawah from frost has now risen to 58 per cent. *Prosopis spicigera* (*cheonkar*) in the same area is practically unaffected.

10. *Hill oaks*.—*Quercus dilatata* seems a much slower and poorer coppicer than either *Quercus incana* or *Quercus lanuginosa*. The two latter coppice well if coppiced below about 8" diameter—above that size they do not coppice well.

#### (iii) Seed supply.

11. The Clutterbuckganj seed store continues its work. The biggest demand was Burma teak (52 maunds) and mulberry (21 maunds).

Germination tests of all seed handled are routine and it is now proved that, of the many species handled, *Acacia arabica* keeps best (seven to twenty-four per cent. germination after six years storage) and *Adina cordifolia* and *Dendrocalamus strictus* worst.

#### (iv) Nursery Work.

12. Nothing special to report.

#### (v) Artificial Regeneration.

13. The advance in skill in artificial regeneration in this province has been phenomenal. Eight years ago, except for the *taungya* in Gorakhpur, the Tarai and Bhabar *shisham* and the Etawah work, artificial regeneration hardly existed except experimentally. What is

more those who tried usually failed except with the easiest species. Now skilled artificial work can be seen almost throughout the province, for example Saharanpur with *taungya*, Tarai and Bahar estates and Haldwani mostly without *taungya*, Bahraich with *taungya*, Gorakhpur with *taungya*, Etawah canals without *taungya*—a very wide range.

Excluding Gorakhpur it is true to say that for every acre eight years ago there are now a hundred done regularly.

Research on general methods is no longer necessary, that stage is past, it is only necessary on particular problems.

14. *Shorea robusta* (*sal*).—Nothing special to report. All reports from divisions show that artificial *sal* regeneration is routine. Failure may occur from grass, weeds, climbers, frost, browsing, etc., but the reason of the failure is definitely known—there is no longer blind groping for reasons.

15. *Acacia catechu* (*khair*).—The Lalkua experiment indicates that only the sturdiest cuttings, properly fenced against porcupine, can hope to survive unweeded under light *kokat* shade. Even that canopy would need early removal. The truth is that although *khair* regenerates easily from root and shoot cuttings under the right conditions, those conditions are tricky and the current divisional practice of clearfelling and sowing is easy and safe.

16. *Pollinidium angustifolium* (*baib* or *sabai*).—The *baib* plantation at Ujhani, from five to seven years old, is now yielding over twelve maunds per acre.

The very detailed experiment in Pilibhit will eventually be written up in full. That experiment and the one in South Kheri show that *baib* is easily propagated and Pilibhit also seems to yield at present about eight to ten maunds per acre.

17. *Santalum album* (sandal).—The Silviculturist's sowings round *Lantana* germinate but various things subsequently kill most of the seedlings. Jhansi also reports failure but natural regeneration goes on steadily. Germination is profuse but there is heavy mortality in the hot weather.

18. *Tectona grandis* (teak).—The all-India teak origin experiment continues satisfactorily in Gorakhpur but frost persistently damages the parallel experiment in Haldwani.

#### (vi) Reclamation and Afforestation.

19. *Usar*.—Nothing to report except that the Makhdoompur experiment continues.

20. *Bhur*.—The afforestation of *bhur* is not difficult with either *shisham*, *khair*, *babul* or *baib* grass. If however the *bhur* soil is com-

bined with some other difficulty like frost, grazing damage, or a specially dry year, then the afforestation of *bhur* is very difficult. Unfortunately *bhur* soil is very often combined with frost.

(vii) *Tending.*

21. Nothing new to report.

(viii) *Mixtures.*

22. Nothing new to report.

(ix) *Underplanting.*

23. In various parts of the Eastern circle experiments have been made in underplanting *sal* with teak, the idea being that *sal* was definitely not regenerating yet teak had to be put in *before* felling because of frost. Without going into further details it may be said that on the whole the experiments were unsuccessful. The teak grew but when the overwood was removed was still often frosted. Areas have been regenerated in this way but it will not be extended.

(x) *Silvicultural Systems.*

24. Nothing to report.

(xi) *Miscellaneous.*

25 Five years burning in the moist *damar sal* type has definitely reduced the evergreen type of undergrowth to something very much less moist and in which *sal* seedlings might survive.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

26. Working plans actually completed during the year were Bahraich, Kalagarh and Ajmer Merwara.

Working plans were in preparation for Haldwani, Jhansi, Naini Tal and East Almora.

Preliminary reports were written for Lansdowne, Saharanpur and Muktesar Laboratory Forests.

(ii) *Yield Tables.*

27. Eighty-nine permanent sample plots mostly *sal* were measured and six new plots laid out in plantations of *sissu*, *khair* and teak.

28. Eight more linear increment plots were laid out totalling ten and-a-half miles. There are now thirty of these plots totalling over 41 miles.

(iii) *Bark Measurements, etc.*

29. Nothing to report.

(iv) *Miscellaneous.*

30. An illustrated book "Our Forests" was issued describing in popular language the work of the Forest Department. The first edition went at once and a reprint has been ordered.

The fifth edition of the "Forest Pocket Book" was sent to press just after the close of the year.

Two more leaflets, "List of Forest tree species of the Dehra Dun division in the order of their frost hardiness" and "Root and shoot suckers of *semal*", were issued during the year, and two more leaflets, "Porcupine fences" and "An approximate volume table for *haldu*" were sent to press just after the close of the year.

Nine talks on various subjects were sent to Dehra Dun for broadcasting.

## CHAPTER III.

### FOREST BOTANY.

#### ASSAM.

##### I.—OECOLOGY.

During the year under review further specimens of grasses and other plants of importance have been collected from the *sal* forests of Goalpara for the detailed study of the different kinds of vegetation and its ecological association. The work is confined to the identification of the species that occur in the region as a preliminary to the investigation of the vegetation and soil types—a task which awaits better times with regard to staff and funds.

The botanical investigation, as mentioned in the last report of the newly explored forest tracts opened up with the construction of the Sylhet-Shillong road was continued but very little work could be done for want of funds. Out of the first consignment of specimens sent to Kew it appears that some of them are likely to be new to science and some had not been previously recorded from India.

##### II.—SYSTEMATIC.

###### *Herbarium work and other investigations.*

The descriptions of the three new species, viz., *Kaula* (Nowgong), *Mekahi* (Sadiya) and *Eugenia* (North Cachar Hills) are being scrutinized by Mr. A. Das who is expected to publish them as the Assam Forest Records, Volume II (Botany) in a few months time.

Neither the *Eugenia* found in Sadiya Frontier Tract by Mr. Purkayastha, the present Botanical Officer, nor a *Quercus* collected by him could be matched at Kew or in India; both are likely to prove to be species new to science.

The forest herbarium has been maintained in good condition. Over 3,000 sheets have been properly mounted and about 500 specimens have been added during the year bringing the total to about 21,300.

Assistance was received from Sibpur and Kew herbaria in naming some unmatched sheets and a fair amount of identification work was also carried out locally for the herbarium and for Divisional Forest Officers. The work of poisoning specimens was also continued as far as practicable by the existing staff and also by employing day-labour during the monsoon when specimens get mildewed.

Duplicate herbarium sheets were distributed as follows :—

Royal Botanic Gardens, Kew	10 sheets.
Lucknow University	212 sheets.
Dr. Bhiragi of Italy	Materials for a critical study of wild and cultivated <i>Citrus</i> of Assam.

The following herbarium materials were lent for study to other persons and institutions :—

Herbarium of the Federated Malay States	All sheets of <i>Shorea assamica</i> .
Mr. A. Das, Late Botanical Officer	Sheets of important species of the groups <i>Thalamiflorae</i> to <i>Calyciflorae</i> for teaching the botany students in the Intermediate Lady Keane Girls' College, Shillong.

Seeds of the following species were supplied as follows :—

<i>Citrus aurantium</i>	Russia, Leningrad.
<i>Coffea khasiana</i>	To Royal Botanic Garden, Sibpur, for supply to institutions outside India.
<i>Modocca trilobata</i>	Ditto.
<i>Shorea assamica</i>	To Forest Botanist, Forest Research Institute, Dehra Dun.

The number of enquiries dealt with by this herbarium during the year under review is as follows :—

Through Conservator	50
Through Divisional Forest Officers	150
Through Institutions and other concerns in and outside India	150

Dr. Bor is studying the grasses of Assam at Kew with the intention of completing the Flora. This is a subject in which the Agricultural Department is really more generally interested than is the Forest Department and, if the former could find funds, an illustrated edition of this portion of the flora could be published dealing with the ecology and fodder value of different grasses. Bombay has produced a publication of this sort with funds supplied by the Agricultural Research Council.

Prof. T. Tanaka of the Imperial University, Taihoku, Formosa, Japan, paid a visit to the herbarium in the latter part of the year in connection with the investigation of *Citrus* culture specially in order to investigate those races that are often confused or are imperfectly known in their wild and cultivated states. He made a very successful tour through the help of this herbarium.

Dr. Bhiragi from Italy also spent some time in the herbarium in connection with the study of the *Citrus* which has become important owing to domestic stocks in Sicily having been largely killed out by disease.

It will thus appear that the herbarium is justifying its existence seeing that it is utilised for reference work not only by Indian institutions but by research institutions and universities in other parts of the world. The Forest Utilisation Officer is consulting this herbarium more than anybody else for information in connection with the development of the trade in various articles of minor forest produce.

### *Staff.*

The post of the Botanical Officer was held by Mr. C. Purkayastha throughout the year, most of his time being taken up however by silvicultural work. With little time at his disposal he corrected the proof of the 2nd Part, Volume I of the Flora of Assam and dealt with a few of the new species that have been recently discovered in Assam.

The staff has carried on the usual routine herbarium work, and all collections made during the year were dealt with in addition to the unmounted specimens which have been lying in this condition for a long time. Proposal for the confirmation of the herbarium establishment has been temporarily postponed.

### IV.—PUBLICATIONS.

The text portion of Part II, Volume I, of the "Flora of Assam" was finished during the year, and to make the book as useful and convenient as possible to the average Forest Officer Indices of botanical and vernacular names have been included. It is hoped that it will be presented to the public by the end of the next autumn.

At the request of the Director, School of Tropical Medicine, Calcutta, the preparation of a report on known poisonous plants was undertaken; materials are already well in hand for its submission.

### BENGAL.

*Botany.*—The Assistant Silviculturist, Mr. Rao, Deputy Conservator of Forests, has been attempting to collect material and obtain data for a revision of the Chittagong flora. In the absence of proper facilities for this work, and also on account of his multifarious duties as Assistant Silviculturist, he has found it impossible to do justice to the work and it was decided that this should pend until a more favourable opportunity occurs.

Dehra Dun continues to give valuable assistance in the identification of specimens.

Research into medicinal plants is also being undertaken at the request of the Inspector General of Forests and Col. Chopra. This offers a wide field of investigation.

## BIHAR AND ORISSA.

*Pathology*.—Angul *sal* trees in Raigoda have been attacked by the thicket fungus. The Forest Mycologist has been requested to investigate.

## BURMA.

*Botany*.—The post of Forest Botanist remained unfilled. Mr. C. W. D. Kermode, I.F.S., held charge of the office of Forest Botanist, Burma, in addition to his own duties as Silviculturist throughout the year. Maung Kan continued to hold the post of Curator of the Herbarium. He was assisted in his work during the rains by several of the foresters on the Silviculturist's staff.

*Herbarium*.—Three hundred and sixty-five sheets were mounted during the year, bringing the total to 39,098 sheets at the close of the year. Due to the absence of a permanent assistant, it was not possible to maintain the herbarium in as good a condition as is desirable. Some of the mounted specimens show traces of damage by insects. The attack originated at Rangoon when the herbarium was temporarily stationed there. The appointment of a permanent Botanical Assistant would make it possible to pay more vigilant and regular attention to the upkeep of the specimens. A considerable number of partially named specimens was sent to Dehra Dun and Edinburgh for naming. Three mounted sheets of *Ellipanthus* sp. were sent on loan to the Forest Botanist, Forest Research Institute, Dehra Dun, for examination and seven mounted sheets of the following were presented to Dehra Dun :—

- (1) *Schizandra axillaris* Hk. f. et T.
- (2) *Alphonsea glabrifolia* Craib.
- (3) *Goniothalamus burmanicus* Fischer.
- (4) *Garcinia paniculata* Benth.
- (5) *Hibiscus grewiaefolius* Hassk.
- (6) *Desmodium reticulatum* Champ.
- (7) *Adhatoda oreophila* Fischer var. *magna*.

In addition to this 9 mounted sheets of the following were sent on loan to the Forest Botanist, Forest Research Institute, Kepong, Selangor, Federated Malay States.

- (1) Two mounted sheets of *Hopea helferi* Brandis.
- (2) Two mounted sheets of *Shorea buchananii* Fischer.
- (3) Two mounted sheets of *Shorea assamica* Dyer.

(4) One mounted sheet of *Shorea cinerea* Fischer.

(5) Two mounted sheets of *Parashorea stellata* Kurz.

Twelve preparations of fixed flower huds of various species for cytological research were supplied to Johan Mauritzon, Boyaniska Laboratorist, LUND, Sweden. Two mounted sheets of *Euphorbia* sp. were supplied to Dr. Leon Croizat, 127 W. 76th Street, New York.

*Presentations and Additions.*—We are especially indebted to Mr. C. E. Parkinson, Forest Botanist, Forest Research Institute, Dehra Dun, for a collection of 70 botanical specimens for the herbarium and to Colonel F. B. Scott, Survey of India, Maymyo, for a valuable gift of 50 specimens collected by him in the Southern Shan States. Contributions were also received from the following officers of the Forest Department :—

(1) Mr. C. W. D. Kermode, Silviculturist, Burma, Maymyo.

(2) Mr. H. C. Smith, Conservator of Forests, Chindwin Circle, Maymyo.

(3) Mr. P. F. Garthwaite, Forest Entomologist, Burma, Maymyo.

*Distributions.*—Duplicate specimens were distributed to the following :—

(1) Director, Royal Botanic Garden, Edinburgh . . . . .	19
(2) Forest Botanist, Forest Research Institute, Dehra Dun . . . . .	48
(3) Forest Botanist, Forest Research Institute, Kepong, Selangor, Federated Malay States . . . . .	34

*Identification.*—Most of the Curator's time was occupied in mounting, writing up labels and disinfecting specimens and in despatch of specimens to other herbaria for comparison and naming. Identification of a fair number of specimens has been done and a lot of doubtful ones have been sent to Kew and Dehra Dun for naming. During the period that the post of the Forest Botanist has been in abeyance a lot of specimens have been identified by the Curator, named, and put into the cabinets. All these need examining and confirming. It is hoped that during the coming year the Silviculturist will be able to do something about this.

*Research.*—The following species new to Burma have been recorded, *vide* Kew Bulletin of Miscellaneous Information No. 10 of 1935 :—

(1) *Schizandra axillaris* Hk. f. et T.

(2) *Alphonsea glabrifolia* Craib.

(3) *Garcinia paniculata* Roxb.

(4) *Hibiscus grewiaefolius* Hassk.

(5) *Desmodium reticulatum* Champ.

- (6) *Mastixia arborea* C. B. Clarke.
- (7) *Vernonia hyalina* C. E. C. Fischer.
- (8) *Androsace gagnepainiana* Hand.—Mazz.

The following species new to science are also described in the same publication :—

- (1) *Goniiothalamus burmanicus* C. E. C. Fischer. Collected by Maung Ba Pe, in the East Swa Reserve, Toungoo.
- (2) *Scolopia kermodei* C. E. C. Fischer. Collected in Bassein, Myaungmya, Insein and North Toungoo Districts by a number of collectors. Also collected in the Andaman Islands.
- (3) *Adhatoda oreophila* C. E. C. Fischer var. *magna*. Collected at Gokteik by C. E. Parkinson.

*Supply of Seeds.*—Seventy lbs. of acorns of *Quercus serrata* were supplied to the Chief, Division of Management, Pretoria, South Africa. Seeds of *Zizyphus incurva* (*sugauk*) and *Harrisonia bennettii* were supplied to the Silviculturist and Conservator of Forests, Ootacamund.

#### Botanical Gardens.

*Charge.*—Mr. C. T. Bogg, Superintendent, was in charge, except for two months from the 6th August 1935 to the 5th October 1935, when he was on leave. In addition, he had charge of the Government House Gardens, Maymyo.

*Municipal Contribution.*—The Maymyo Municipality again contributed the sum of Rs. 1,200 towards the maintenance of the garden. This was utilised for improvements to roads and buildings.

*General Conditions.*—The springs started functioning in September and early in November the Lake overflowed and continued to do so until the middle of March 1936. Every effort was made to keep the grounds tidy but with the limited staff it was impossible to keep jungle growth in check during the months of August to November.

There was again a very favourable growing season. The Lily garden benefited from having been replanted last year. The Dahlias showed great improvement in size and colour, some blooms being more than 12 inches in diameter.

*Orchids.*—The collection now has 150 correctly named species and some 50 odd specimens have been sent to Kew for correct naming. Kew named the following species :—

*Dendrobium bellatulum* Rolfe.

*Cymbidium lancifolium* Hook.

*Cymbidium pendulum* Sw.

*Bulbophyllum secundum* Hook.

*Saccolabium micranthum* Lindl.

*Dendrobium heterocarpum* Wall.

*Microstylis wallichii* Lindl.

*Dendrobium acinaciforme* Roxb.

*Pholidota pallida* Lindl.

*Sarothrochilus dawsonianum* Schltr.

Of the above, 9 have not flowered or been received before in the garden and are new to the collection. A living plant of *Pholidota pallida* Lindl. which has smaller flowers than the type, has been asked for by Kew.

Orchid plants were received from several Forest Officers and it is due to their generous support that progress is maintained.

*Season.*—The season was favourable and though the abnormal rainfall early in November (7 inches in two days) did wash away the first sowing of annual seeds, it benefited the Lake and newly planted trees which this year survived the frosts of December and January without damage.

The total rainfall was 64.44". It was well distributed during the period April to November. There were 128 rainy days and the greatest rainfall was experienced on 6th November 1935, when 4.95 inches was recorded. Frosts were not as severe as in the previous year and consequent damage was negligible.

## CENTRAL PROVINCES.

### III.—PATHOLOGY.

Fungi are reported to be doing considerable damage in certain *babul* (*Acacia arabica*) plantations in Amraoti.

In West Berar, *Loranthus* was very common on *salai* (*Boswellia serrata*) and *achar* (*Buchanania lanzan*): badly attacked trees were felled and infested branches lopped.

## CHAPTER IV.

## FOREST ENTOMOLOGY.

## ASSAM.

Large scale defoliation of *sal* took place all over the division and larvae of 4 different kinds of moths were collected by Mr. De, Deputy Conservator of Forests, Kochugaon division, and sent to Dehra Dun for identification.

## BENGAL.

Measures for the control of the *champ* bug (*Urostylis punctigera*) were suggested by the Forest Entomologist, Dehra Dun, and experiments on a large scale will be made during the hot weather and rains at Sukna.

It is suggested that spraying with a solution of soft soap and tobacco juice offers the most possibilities, but that biological control should also be studied. The former method will be tried out first.

## BURMA.

## A.—PESTS OF TEAK.

I.—*Xyleutes ceramicus* Wlk., the Beehole Borer.

## (a) Life History.

In the Thogale cage the bulk of the survivors of the larvae introduced in 1934 emerged as moths after one year; two larvae continued into the 1935 season and were still working in April 1936.

In the Zibingyi cage 16 larvae had been introduced in 1934; the 5 reported as surviving last year were working throughout the 1935 season, but all had failed by the hot weather of 1936, and no moths emerged.

In the Maymyo cage only one of the larvae introduced into the trees in 1934 survived to pass into its second year. It worked vigorously up to the end of December 1935, and a moth emerged on 30th April 1936.

Eight *X. ceramicus* larvae were introduced in July 1935, but all except one failed to survive. A male moth emerged on 10th May 1936.

2. Definite evidence regarding the length of the emergence period of the moth in various parts of Burma is not yet forthcoming. In the Thaungyin division the first moth was seen on March 14th, 1936.

Rising of the sap in teak had first been noticed four days earlier. At Thogale, South Toungoo division, the first moth was found on March 20th, and adults were still emerging in the third week of April.

3. *Laboratory Experiments with Eggs of X. ceramicus.*—It is apparent that temperature and not humidity, which has practically no effect, is the controlling factor governing the hatching of the eggs. A constant exposure to a humidity of 5 per cent. or to absolute dryness inhibits development. Exposure to temperatures of 104° F. and 61° F. kills the eggs after only a few hours. Such a narrow range is rather surprising when one considers that the former temperature must obtain daily over a large percentage of bark surface, even in the optimum habitat of *X. ceramicus*, and that the latter limit must be very closely approached on frequent occasions during the incubation period. The stage of development of the embryo within the egg at the time of an experiment is immaterial, all stages reacting similarly to a given set of conditions. Neither temperature nor humidity (except those stated) seem to have any influence on the hatched larvae, the duration of life without the host being approximately four days.

The period of incubation of eggs was found to be 16 days, which corresponds to that observed in the Philippines.

4. *Alternative hosts of Xyleutes ceramicus.*—*X. ceramicus* larvae have been found boring in *Vitex peduncularis* in Thaungyin. Two of these were introduced into caged teak trees at Zibingyi, and moths emerged in April 1936; larvae introduced into *Vitex carbuncularum* all died within a week of introduction.

*Vitex parviflora* is a commonly recorded host of *X. ceramicus* in the Philippine Islands, though teak there is also attacked.

5. *Life history observation plot in the 1921 plantation at Thogale, Pyuchaung Reserve, South Toungoo division.*—1934 attack. Of the 20 surviving larvae recorded as passing into their second year in March 1935, only three were working at the end of July 1935, and in February 1936 only two individuals were alive out of an original record in 1934 of 80 larvae, some of which were, however, transfers, one being recorded for the first time as late as January 1935. Of this year's survivors only one had been taken by a woodpecker.

1935 attack.—The first record of the new attack in June 1935 revealed the fact that 73 new larvae were working in the 243 trees in the plot, and a further 86 new galleries were recorded at subsequent visits.

The majority of the later records of 46 new galleries in September, one in November and two in February 1936 must have been transfers from other galleries recorded as failed, as by July or August all the larvae hatched from eggs laid in April would show visible signs of their presence in the trees and would be recorded. Thus the total attack for the year was 159 beeholes, or 0.65 per tree, compared with 0.32 per tree in 1934 and 2.86 per tree in 1933 and an average of 2.04 beeholes per tree per annum since 1930. By February 1936, 81 of these larvae had failed, woodpeckers being responsible for 25 of the failures; in only three cases had a separate bole been made by the woodpecker, the remainder of the larvae being taken from the mouth of the bole. In February 1936, 54 larvae were working in the trees, and 24 were doubtful.

When the final record of the year was taken at the end of the moth emergence period in April 1936, 6 had emerged as moths after only one year as larvae, a further 46 had failed, leaving 19 living larvae *plus* 8 doubtful ones to pass into their second year.

In addition a moth emerged from a hole which had not been ringed, which must be recorded as an attack of 1935, bringing the total attack to 160 holes in 243 trees.

(i) *Annual incidence.*—The average annual incidence per tree for the six-year period 1930 to 1935 in this plot has been 2.04 beeholes, the average number of trees being 245.

Year.	1930.	1931.	1932.	1933.	1934.	1935.	Period 1930-35.
Total beeholes recorded.	1,102	409	545	701	80	159	2,996
No. of trees	247	246	246	245	243	243	245
Average beeholes per tree.	4.46	1.66	2.21	2.86	0.32	0.65	2.04

The attack in the last two years has been considerably below the average. A certain biennial rhythm can also be seen, a year of high incidence being followed by a year of lower incidence. This indicates the normal two-year life cycle of the borer, though the fact that moths can emerge after only one year in the larval state has been proved in the observation plot. The two-year life cycle must, however, be regarded as normal, and the factors which cause some individuals to complete their life cycle in a single year are at present unknown, but are probably physiological.

(ii) *Effect of aspect on beehole incidence.*—The annual incidence per tree on the southern and on the northern aspects is compared in the following table :—

SOUTHERN ASPECT.					NORTHERN ASPECT.				
Year.	Bee-holes.	No. of trees.	Average bee-holes per tree.	Average for period 1930-1935.	Year.	Bee-holes.	No. of trees.	Average bee-holes per tree.	Average for period 1930-1935.
1930 .	348	91	3.82	1930	1930 .	744	156	4.77	2.25 Beehole per tree.
1931 .	115		1.26	1.66	1931 .	294	155	1.89	
1932 .	167		1.83	Bee-holes per tree.	1932 .	378	155	2.44	
1933 .	168		1.84		1933 .	533	154	3.46	
1934 .	32		0.35		1934 .	48	152	0.31	
1935 .	76		0.84		1935 .	83	152	0.54	

Thus the incidence in the trees on the southern aspect has, with the exception of the last two years, in which the incidence has been relatively light throughout, been consistently lighter than that of the trees in the northern half. The average breast height girth of the trees in the two halves is the same. The limiting factors of the beehole incidence in the southern half of the plot are almost certainly climatological, the hot sun and dry conditions on the southern aspect being less favourable to the egg and early larval stages of the horer than the more shady, moister conditions which obtain on the northern aspect.

(iii) *Variation of beehole incidence with size of trees.*—Previous observations and the records obtained from analysis have indicated that in a given stand of trees beehole incidence varies directly with the volume of timber in the tree; the larger the tree the greater the number of beeholes, other conditions being equal. The following table shows the average annual incidence per tree for the six-year period 1930-1935 in the five six-inch girth classes present in the plot, measured in November 1935.

Girth Class.	1 1'0"—1'6".	2 1'7"—2'0".	3 2'1"—2'6".	4 2'7"—3'0".	5 3'0"—3'6".
No. of trees . . .	24	90	90	35	6
Average annual incidence per tree 1930-1935.	1.14	1.58	2.34	2.9	3.1

Though the larger trees are more liable to attack, when the economic damage is taken into consideration, i.e., the number of beeholes per

unit of volume, it is probable that all five classes are damaged to a similar extent. The reason for the greater liability to attack of the larger trees is thought to be two-fold; first the egg-laying habits of the female moth make it more likely that on an average a greater number of eggs will be laid on trees with a larger surface area than on small trees; and secondly young larvae will find physiological conditions of development more favourable on large than on small trees. A third factor may enter into the question—the predators; woodpeckers and ants, working up a small tree, would be likely to meet with and destroy a greater percentage of eggs and young larvae than they would on a large tree.

(iv) *Height distribution.*—The height distribution of all beeholes recorded since 1930 showed that during the six years the greatest number of beeholes were recorded between two and six feet from the ground, the curve falling away very steeply after this to twelve feet up the bole, then more gently to twenty-seven feet, above which comparatively few beeholes were recorded. The annual curves of height distribution show approximately the same trend, though that for 1935 shows that the zone of greatest attack has moved up slightly, the greatest number of records in that year being between 8 and 11 feet from the ground. This is in accordance with the results of analyses which show that the site of greatest attack tends to move upwards towards the crown as the tree gets older.

(v) *Habits of the beehole larva when transferring itself from one hole to another.*—The majority of the 46 fresh galleries of the 1935 attack recorded in the September visit to the plot were thought to have been caused by larvae which had vacated former galleries, and the three fresh galleries recorded at later visits were certainly transfers. A larva recorded for the first time in November at 8' in one tree had almost certainly transferred itself from a hole recorded as failed in a tree ten feet away. The actions of larvae extracted from their galleries at various times of the year and placed on the bark of the tree were observed, and it was seen that the young larva, two or three months old, rapidly ate away a small portion of the outer bark, covered itself with a protective web and subsequently formed a fresh gallery. Older larvae, however, taken from the trees in December, were much more sluggish, and unless they found a crevice or rough patch of bark, were attacked and pulled down by ants before they could cover themselves with a protective web.

#### (b) Analysis of Past Attacks.

6. The results of the survey of beehole conditions throughout the province by Mr. D. J. Atkinson, I.F.S., have been published. With this

publication the first phase of the beehole investigation may be said to be ended. The beehole incidence throughout the main teak bearing areas in Burma is now known, and regeneration policy can be based on these results. The next phase in the investigation is the study of the factors influencing beehole incidence in each locality, and of the causes of local and wider variation in beehole incidence.

A start was made in this investigation during the year and hand analysis was carried out in the following areas :—

In the Pile Reserve, West Katha division, four separate plantations and some natural trees were analysed. The plantations were all in the heavy zone of beehole incidence, and the natural trees, of which the average age was 52 years, in the medium zone. It was found that beehole incidence in the natural trees had increased rather rapidly in the last 18 years, and that if the age-beehole incidence curve follows its present trend, these trees will enter the heavy zone in another ten years or so.

Each locality was examined also from the point of view of economic damage, i.e., number of beeboles per unit of volume at each year of age of the tree, from which data a curve can be drawn for comparison with the results of all other localities. The natural trees in this locality all showed zones of suppression in their growth rings, and it was found that in spite of their lighter beehole incidence, they contained a greater number of beeholes per cubic foot for age than did the trees in three of the plantations analysed, these trees being taken from the dominant classes and averaging first quality.

This shows that even if a greater beehole incidence may be found in plantation trees than in natural trees in this locality, the better growth increment of the best of these plantation trees makes them damaged to a less extent than the suppressed natural trees by their lighter incidence.

In the Gwethe Reserve, North Toungoo division, analysis was carried out in a 1921 plantation and in an area naturally regenerated by a seedling felling in 1916. The beehole incidence in the plantation was the highest so far recorded, 33 beeboles per tree, at 14 years of age, which is ten beeboles per tree more than the Thaungyin plantation trees at the same age, hitherto considered to be the locality with the heaviest incidence in Burma. The trees in the naturally regenerated area had, however, an even higher incidence containing 75 beeboles per tree at 18 years of age. An examination of the annual incidence in the trees was of great interest, showing to a marked degree a biennial rhythm in

the attack. The plantation trees, for instance, gave the following results :—

Year.	Beeholes per tree.	Year.	Beeholes per tree.
1922 . . . .	(18 trees). Nil.	1929 . . . .	3.9
1923 . . . .	0.06	1930 . . . .	1.44
1924 . . . .	0.06	1931 . . . .	5.55
1925 . . . .	1.6	1932 . . . .	1.7
1926 . . . .	0.28	1933 . . . .	6.7
1927 . . . .	2.6	1934 . . . .	2.55
1928 . . . .	1.1	1935 . . . .	7.4

The other locality analysed gave similar results, the years of greater incidence being the same, 1925, 1927, etc. This biennial rhythm indicates the two-year life cycle of the beehole borer in this locality.

Great though this incidence is, growth in this locality is so good that the volume-beehole incidence curves show it to be less damaged than other areas of lower beehole incidence but poorer growth.

The plantation is a mixture of teak (*Tectona grandis*), *pyinkado* (*Xylia dolabriformis*) and *padauk* (*Pterocarpus macrocarpus*), planted originally in 30-foot strips of each species, therefore, in an area liable to beehole, mixture of teak with other species in a plantation can have no effect on checking beehole incidence.

Two further localities were analysed at Mohnit, Kaing Reserve, Pyinmana division. A portion of a 1912 plantation had previously been analysed by hand and found to be in the heavy zone of beehole incidence. A 1900 plantation adjacent to it, and growing under apparently identical conditions, was analysed in 1934-35 by the mill method, and found to be in the light-medium zone of beehole incidence. Further hand analysis was undertaken in the 1900 plantation, and the apparent anomaly of these greatly differing incidences in adjacent plantations growing under identical conditions was cleared up. Until 1920 the older plantation had suffered a very light annual incidence. Since that year, however, it had suffered a much greater, and an increasing annual incidence, in fact the same degree of annual incidence as the 1912 plantation. As the 1912 plantation had suffered this higher incidence since it was first liable to attack, the summation age-beehole incidence curve showed it to be in the heavy zone, whereas the cumulated attack in the older plantation, in spite of the increase in recent years, was still of only medium severity.

The curves for height distribution of beeholes showed that in the 1900 plantation the site of greatest attack is now half way up the bole, and beeholes accrued from now on are more likely to be in the top half than the bottom half of the stem. It is, therefore, evident that the basal 20 feet of stem of the trees in this plantation are always likely to be in the light zone of beehole incidence, whatever the future attack.

Seventeen trees were analysed in the most northerly portion of the 1912 plantation (previous analysis had been in the southern portion a mile away); the incidence was found to be in the medium zone. There was, however, very great variation of beehole incidence in individual trees. The indications are that in those areas liable to moderate beehole incidence there can be great variation of attack in individual trees, and that this variation can be correlated with site, trees growing in the more exposed situations being less liable to attack than those in moist shady sites.

In the Bhamo division analysis was carried out in three areas. A group of natural trees was analysed in the Momauk Reserve, at the foot of the Sinlum hills, in which the incidence was in the heavy zone, but considerably lighter than had been previously thought to be the case in this locality.

A 1924 plantation was analysed in the Sanitu regeneration centre, Nanme Reserve, which was found to be in the heavy zone, the incidence increasing rather rapidly. The biennial rhythm of attack was again evident in the annual incidence. Growth increment was so good in the trees analysed that it was outstripping even the increasing borer increment, and from the point of view of economic damage, the trees analysed were in the medium zone.

A 1920 and a 1922 plantation were analysed in the Simaw Reserve, and though beehole incidence was found to be moderate in both these plantations, there was present also a very high incidence of the *Phassus* borer, the gallery of which has the same course as the beehole, and which appears to be dependent on a creeper for its development. This *Phassus* borer is dealt with later in the report, but in this locality the combined incidence of these two borers was very heavy indeed, and the *Phassus* galleries were in the majority, though there are signs that since 1931 the *Phassus* incidence has been greatly reduced, probably owing to rigorous creeper cutting in the plantations since that date.

The 1921 plantation analysed in the Myohla Reserve, North Toungoo division, was found to be in the medium zone of beehole incidence, confirming the results of previous analyses in the same reserve.

### (c) Natural Enemies.

7. The ichneumonid parasite of the beehole borer, *Nemeritis tectonæ* must emerge from its alternate host to oviposit in the young beehole

larvae soon after they have hatched from the egg at the end of the moth emergence period. The whole flora of the Nanhlaing reserve plantations, Shwebo division, and the forest surrounding them was examined for an insect fulfilling the necessary conditions, i.e., that the insect should either be a borer in a plant species as common as teak in that locality, or else a polyphagous species as common as *Xyleutes ceramicus*, and that it should be in a fit state for parasitisation by the ichneumonid in September, when the parasite has emerged from the beehole. The survey disclosed two possible insects which fulfilled the necessary conditions. A species of strobilanth with a woody stem is very common in these plantations and harbours borers, much the commonest being a lamiid, *Oberia* sp. and a weevil, *Alcidia* sp. No parasite cocoons resembling those found in the beehole were discovered. Cocoons containing living parasites were caged, from which later 8 braconids emerged.

The only other possible host was the larva of a hepialid moth, *Phassus* sp. found in very great numbers both in and around the plantations, dependent on a creeper, *Buettneria pilosa* Roxb. This creeper is very common in this locality and in every tree supporting it were found galleries of the *Phassus* borer.

There is strong circumstantial evidence that this *Phassus* borer is the alternate host of the beehole borer parasite, *Nemeritis tectonae*.

In the Nanhlaing Reserve, Shwebo division, three living parasites were taken from beeholes. One male *Nemeritis tectonae* emerged from one of these cocoons on the 4th September.

The cocoons of a second species of ichneumonid parasite, hitherto recorded only once, from Pinyinmana, were found in a beehole in the Momauk Reserve, Bhamo division, and the tachinid parasite, *Podomyia atkinsoni*, was recorded, though not commonly, in each area analysed.

## II.—Defoliators.

8. The Insectary was transferred from Pinyinmana at the beginning of the year to Insein to facilitate a survey, similar to that carried out at Pinyinmana, of the distribution of the parasites of the defoliators in the important regeneration centres of the Pegu Yomas.

Defoliation and skeletonisation by *Hyblaea pueru* and *Hapalia machaeralis* respectively was more severe during the year under report than it had been the previous year, the former being confined to the early rains and the latter to the period August to December. 28 reports of damage by these insects were received from 8 divisions, material for breeding purposes being sent on 20 occasions. No regeneration centres in the Pegu Yomas, as far as could be ascertained, escaped damage by one or the other of these insects, though that done by *Hapalia*

*machaeralis* was the more serious. This was especially so in the Konhilin Reserve, Tharrawaddy division, and in the Bwet Reserve, Prome division, where skeletonisation starting in September resulted in the killing off over large areas of the leading shoots in the younger plantations up to six years old.

Mixed teak plantations and trees in natural forest suffered to as great an extent as trees in pure teak plantations, which confirms the previous indications that it is the state of the under-growth rather than the main crop and understory which has the greatest influence on the incidence of defoliation.

An outbreak of *Hyblaea puera* in June, which might have been serious, disappeared during the next month, during which rainfall statistics showed that the greatest precipitation of the year occurred. That heavy rainfall is unfavourable, and dry conditions favourable to *H. puera* has been observed in other localities.

That *Hyblaea puera*, like *Hapalia machaeralis*, carries on its generation in the cold and hot weather, though in greatly reduced numbers and has no dormant stage, was indicated by the finding of a fifth instar larva on 19th February 1936. The larva pupated on 21st February and the moth emerged on the 28th.

No new host plants of either species were recorded; *Hapalia machaeralis* is, in Burma, able to exist on teak alone throughout the year, as there is always teak foliage of some sort available. The fifteen recorded alternative host plants of *Hyblaea puera* serve to carry it over the period when tender teak leaves are scarce.

A floral survey was carried out in sample areas in plantations affected and unaffected by the defoliators during the year as a preliminary study of the environmental factors influencing attack and also to make as complete a survey as possible of the predators and parasites in a given area. To get the maximum utility from such a survey, meteorological data is also required from the areas sampled, but these were unavailable.

9. *Insectary Work*.—(a) *Hapalia machaeralis* Wlk. Generation series were run from locally collected material, the series having run into ten generations of average length 27.4 days by March 1st 1936. The dominance of females, established at Pinyinmana after the 13th generation of the original series, has been entirely absent from the material so far bred at Insein.

Further evidence of an apparent hibernation of *H. machaeralis* in the prepupal stage was obtained, material collected in December remaining in this stage for a maximum of 54 days (the normal period is two days).

*Parasites*.—5 species of *Braconidae*, 5 *Ichneumonidae*, 5 *Chalcidae* and five species of *Tachinidae*, all hitherto unrecorded, emerged from material collected during the year. All of these were larval parasites. A notable absentee, commonly recorded at Pyinmana, was the braconid, *Cremnops desertor* L.

During the defoliation investigation at Pyinmana and Insein, 39 different species of parasites of *Hapalia machaeralis* have been bred from collected material, ten of these being *Braconidae*, ten *Ichneumonidae*, ten *Chalcidae* and nine *Tachinidae*. One braconid and 8 chalcids are hyperparasites. Only 10 per cent. of these species have been expertly identified.

(b) *Hyblaea puera* Cram. No attempts were made to run a generation series of this insect in the Insectary during the year.

*Parasites*.—11, 565 larvae and 5,080 pupae collected in the field were handled in the Insectary for purposes of rearing parasites. Two species of *Ichneumonidae*, hitherto unrecorded from *Hyblaea puera* in Burma, were bred from this material, and in addition two species of *Braconidae*, 4 *Ichneumonidae*, 3 *Chalcidae* and 4 *Tachinidae*.

The total number of species of parasites of *Hyblaea puera* in Burma is now twenty three, consisting of three species of *Braconidae*, nine *Ichneumonidae*, seven *Chalcidae* and four *Tachinidae*; two tachinids and two chalcids are common to both *Hapalia machaeralis* and *Hyblaea puera*.

10. *Predators of the defoliators*.—Ninety specimens of predators, *Carabidae* larvae, *Mantidae*, predatory *Hemiptera* and spiders were reared in the Insectary.

### III.—Other Pests of Teak.

11. *Phassus* sp. must now be regarded as one of the major pests of teak, and of many other species. It appears to be intimately associated with the creeper, *Buettneria pilosa*, and is not found where this creeper was absent from the flora. The early larval stages appear to be spent feeding in the creeper, the larva subsequently transferring to whatever tree supports the creeper, and constructing a gallery therein very similar in appearance to that of *Xyleutes ceramicus*; it goes in for about three inches and then runs upwards for a maximum of ten inches parallel to the axis of the tree. The size of the gallery seems to depend on the size of the stem in which it is constructed. Living larvae were introduced into the caged teak and *Callicarpa arborea* trees in the Maymyo Insectary in May, and four moths emerged from these between 27th September and 1st October 1935. There was also

found in May in the Nanhlaing plantations a gallery from which a moth had recently emerged, so it is probable that there may be two generations in the year.

In the Simaw Reserve, Bhamo division, the teak trees analysed for bcebole incidence were found to have suffered a very severe attack by this borer, the incidence having increased to a peak year in 1931 after which it had fallen away, and in January 1936 no living larvae of this species were found either in teak or in other species round the plantations. This could be correlated with the observed scarcity of the creeper at the present time, which has been vigorously cut back in recent years. Old dead stems of the creeper were abundant, and an examination of such stems revealed signs of attack exactly similar to those connected with the current *Phassus* attack found in the Nanhlaing Reserve, Shwebo division.

This borer was found to be plentiful in the *Gmelina arborea* plantations at Namtu, Northern Shan States, where living larvae were found in August in galleries in the *Gmelina arborea* trees, which had entered, as before, from the same species of creeper.

12. *Other borers of teak.*—A note on the borers which are dependent on creepers was written during the year and circulated in a Forest News Bulletin by the Chief Conservator of Forests.

13. The results of the experiments to determine the immunity against attack by bostrychid beetles of the genus *Dinoderus* conferred on bamboo dunnage by soaking in water have been published as a Burma Forest Bulletin.

#### B.—PESTS OF OTHER SPECIES OF ECONOMIC IMPORTANCE.

14. *Calopepla leayana* Latr. In the *Gmelina arborea* plantations at Namtu, Northern Shan States division, up to August, 1935 in spite of a dry May, normally considered favourable to the beetle, defoliation had not been of greater severity than in 1934; the area of trees killed by the beetles was not increased; this may have been due in some part to the vigorous mechanical methods of control practised in 1934 and in the early months of 1935, by which 14-14 lakhs of beetles of the potential breeding population of the 1935 season were destroyed.

It was the second generation which did the greatest amount of damage during the year, and beetles persisted in the plantations until November, extending the area of defoliation and allowing of no recovery for the trees defoliated by beetles of the first generation. There are now only 979 acres of plantations out of an original 2,084 acres, which have sufficiently survived defoliation as to be worth tending.

The methods of control employed by the division were :—

(i) *Trapping with white sheets*.—1.47 lakhs of the potential breeders of the 1935 attack were trapped in August 1934 on their way to hibernation. The method was tried on the first arrival of the beetles into the plantations in May 1935, but with no success; similar trials up to the end of July were also unsuccessful, so it seems it is only as they depart for hibernation that the white sheets have any attraction for the beetles. In August 1935, 4.60 lakhs of beetles were trapped in spite of unfavourable climatic conditions; these are potential breeders of the 1936 attack. Given sunny spells of weather in August, when the beetles of the first generation depart for hibernation, this method is the cheapest and most effective. 2,000 beetles were taken in one sheet in half an hour on one such occasion.

(ii) *Destruction in hibernation quarters*.—Beetles were found to hibernate not only under bark but in crevices and old insect holes in dead or dying trees, where they are safe from fire, in thatch on house roofs and in bamboo fence rails. Beetles were found in hibernation over a mile from the plantations. No beetles were attracted to artificial traps resembling hibernation quarters. In 1934-35, 2.51 lakhs of beetles were destroyed in hibernation.

(iii) *Hand picking*.—This was vigorously practised when the beetles first made their appearance in the plantations up to the time when egg laying was completed and 5.88 lakhs of beetles were destroyed. Subsequently 4.28 lakhs of beetles of the new generation were destroyed by this method.

The potential breeding population of the 1935 attack was reduced by these operations by 14.14 lakhs of beetles. That even the destruction of this number was not sufficient to prevent very serious damage is clearly shown in the final report of the Divisional Forest Officer, and it is evident that methods of mechanical control alone cannot prove effective.

Generation series of the parasites of *Calopepla leayana* were run in the Maymyo Insectary. Overwintered pupal parasites were successfully used for parasitising the first available *Calopepla* pupae. During the winter the parasites were regularly exposed to light, and this may have ensured fertilisation.

At the end of the year it was learnt that the *Gmelina arborea* plantations at Namtu were to be abandoned.

*Xyleutes persona*. Moths of this species emerge throughout the year and there is no definite moth emergence period such as is the rule with *X. ceramicus*.

Larvae were seen in the act of transferring from one hole to a fresh one and their habits while so doing were noted.

A pair of wild moths was found in copulation in February 1936, and the resultant eggs were collected; the number laid has been calculated as 12,000.

15. *Lyctus* attack on stored material. In August 1935 a report was received from the authorities at Mingaladon Cantonment, Rangoon, of attack to packing cases and other materials stored in their godowns. The packing cases were found to be attacked by *Lyctus* beetles, tent pegs by the bostrychid *Sinoxylon anale* Les., and bundles of rope by *Anobiidae*. Attack in each case had probably originated before the arrival of the material in Rangoon.

16. *Pyinkado* borers.—A considerable number of *pyinkado* sleepers supplied for the contract with the Indian Railways had to be rejected by the Forest Economist owing to their "wormy" condition. The majority of these came from forests in the Ataran and Thaungyin divisions, and the borers responsible appeared to be a lamiid and a cerambycid.

### C.—GENERAL INSECTARY WORK.

17. 165 cages were in use at the close of the year, mainly for the breeding of wood-boring insects. 23,419 insects emerged during the year and 1,581 were set and mounted. Identification of specimens in the collection is being carried out as rapidly as possible.

## CENTRAL PROVINCES.

### A.—ZOOLOGY.

*Nagpur-Wardha*.—An epidemic of rinderpest in the Pench ranges is reported to have resulted in the death of many sambhur and chital.

*Nimar*.—Blue bulls are doing much damage to the reproduction of *Anogeissus latifolia* and *Hardwickia binata* in recently clear felled coupes and chital are very destructive to young teak.

*Mandla*.—A very large proportion of the advance growth of *sal* was observed by a number of inspecting officers to have suffered from the browsing of deer. Similar damage is very apparent in the *sal* forests of Balaghat, Bilaspur and Raipur.

*Melghat*.—Much damage has been caused by sambhur and barking deer to the bark of *Adina cordifolia*, *Madhuca latifolia* and teak. The severity of the attack is attributed to the scarcity of the *mahua* flower and of the fruit of the *aonla* (*Embllica officinalis*). Damage by porcupines to several species was also noticed.

*West Berar*.—Ravages by wild cattle, known locally as *deogai* continued, and netting operations were again undertaken, as a result of

which 101 cattle were captured. Of these 13 died and the remainder were sold for Rs. 600.

*Yeotmal*.—Wild cattle caused similar damage both to forest and to cultivation in the Pathroat reserve of the Yeotmal division, where they are reported to be increasing. In the same division, bison, blue bull and chital were responsible for widespread damage, particularly in the agrisilvicultural plots.

*General*.—With the introduction during the past ten years of methods of concentrated regeneration in almost every division, the very serious damage caused to reproduction by various wild animals, particularly chital, is every year becoming increasingly obvious, and it is now clear that the existence of large herds of deer is so inimical to silviculture in many forests that immediate steps must be taken to reduce their numbers or to fence regeneration areas, if reproduction is to be enabled to establish itself.

## B.—ENTOMOLOGY.

*Teak*.—The teak defoliators (*Hapalia machaeralis* and *Hyblaea puera*) were much in evidence in the vicinity of Garpit in the Nagpur division, but their attacks were not serious in other divisions. The roots of teak seedlings in the Borwadi agrisilvicultural plots in Yeotmal were severely attacked and killed by a larva identified at Dehra Dun as a species of *Lachnosterna*.

In the same division serious cankerous damage was noticed near the leaf whorls of young teak, and a larva associated was identified at Dehra Dun as *Arbela tetraonis*. The damaged stem is liable to snap at the point of attack, and thus to cause forking and lessen the value of the timber. This form of injury is said to be chiefly confined to poor quality teak forests and to localities exposed to wind. Similar attacks are reported in Amraoti and in the Melghat.

*Sal*.—A certain amount of apprehension was aroused by a recrudescence of the attacks of the *sal* borer (*Hoplocerambyx spinicornis*) in parts of the Mandla division. Vigorous control measures on the lines now standardised were promptly carried out and all attacked trees have been dealt with in both the Mandla and Balaghat divisions. In Mandla nearly 8,000 heetles were caught on trap trees at a cost of Rs. 75, and 7,400 attacked trees were felled and burnt at a cost of Rs. 4,400. In Balaghat, where the attack was less serious, it was observed that in a coupe marked early in the rains during the swarming season, the blazes on the marked trees had attracted the beetles in large numbers, with the result that many of these trees were attacked and later served the purpose of trap trees. Minor attacks of the same insect were reported

from Bilaspur. Immunity from epidemic attacks of this menace can only be assured by constant vigilance.

Damage to *sal* timber felled in Balaghat during the hot weather was found on reference to Dehra Dun to be the work of *Aeolesthes holosericea*.

*Bombax malabaricum*.—Slight attacks of the budworm, *Tonica niviferana* were observed in the experimental plot at Chorboli in the Nagpur division.

*Sterculia urens*.—In Jubbulpore the trees tapped for *kareya* gum were found to have been attacked by the larvae of longicorn beetles of the species *Plocaederus* and *Batocera*.

*Lantana*.—In the Melghat division an epidemic invasion of the larvae of *Diacrisia obliqua confusa* occurred during the rains. The caterpillars appeared to prefer *lantana* to all other species, particularly in the sheltered valleys. The attack lasted from August to October and in the later weeks the larvae were killed in large numbers by parasites. As a result of the defoliation of the *lantana*, teak advance growth suppressed by it responded to the admission of overhead light. The life cycle of the insect is being studied at Dehra Dun.

## MADRAS.

### SPIKE DISEASE OF SANDAL.

#### *Transmission experiments with insect masses, families or groups.*

(i) *Cloth cages*.—In the 6-acre regeneration plot at Javalagiri, 115 sandal plants artificially raised in a spiked area were protected by covering them with cloth cages from April 1932 to April 1935. No caged plant got spiked whereas among the controls 14 per cent. got the disease. These results indicate that the infecting agency is not in the soil but is one operating above ground. The experiment is being repeated by caging another set of 144 plants from May 1935 after testing by lopping that they contain no masked infection. Among the 115 plants originally caged in April 1932, 73 died as the result of caging during the course of the experiment. The remaining 42 have been left open since May 1935 to see if they now get the disease. No spike has yet appeared.

(ii) *Wire mesh cages*.—To see what sized mesh screen would allow the infective agency to reach the plant, 849 plants were selected in an infected area in Noganur R. F., tested to contain no masked disease and then allotted as follows:—

800 for controls.

10 caged with wiregauze of 20 meshes to an inch.

10 caged with wiregauze of 10 meshes to an inch.

9 caged with wiregauze of 4 meshes to an inch.

10 caged with wiregauze of 2 meshes to an inch.

10 caged with wiregauze of 1 mesh to an inch.

Of the above, the cages of 10 and 20 meshes and 3 of 4 meshes, were started in the year 1933, 10 of 1" netting; 9 of  $\frac{1}{2}$ " netting were started early in 1934, and the remainder in 1935. Every time before caging, the plants were tested for masked symptoms, by pruning. In October 1935 one plant of 1" netting showed spike. Among the uncaged controls, 162 plants or 20.25 per cent. had become spiked up to the end of January 1936. All these cages including those of 20 and 10 meshes to an inch, freely allowed the settlement of coccids and other insects on the plants.

These experiments have eliminated the possibility of infection by air-borne infective spores and fungi and have also given the indication that the search for the culprit insect should be made among the bigger classes of insects although the very small insects such as aphids, thrips and coccids are not conclusively eliminated.

(iii) *Pot plants on platforms and on the ground.*—Plants raised in pots in a healthy area (*viz.*, Potculture plot at Denkanikota) from seeds collected from the best sandal trees of a healthy locality (Hosur Cattle Farm) were transported to the infected area at Aiyur and exposed on 8' to 10' high platforms and also on the ground for varying periods. At the end of these periods of exposure, they were transferred back to the healthy area. Of these a certain number of sandal plants as detailed in the statement were found infected.

NUMBER OF PLANTS.		Period of exposure.	NO. OF PLANTS SPIKED.		
On platform.	On ground.		On platform.	On ground.	Date of manifestation.
14	7	23rd April 1931 to 31st July 1931.	1	..	Feb. 1932.
14	7	4th Mar. 1932 to 6th May 1932.	2	..	Jan. 1933.
14	7	6th Oct. 1932 to 10th Dec. 1932.	2	..	Feb. 1933.
14	7	13th April 1933 to 11th June 1933.	1	..	Jan. 1934.
14	7	13th Aug. 1933 to 30th Oct. 1933.	2	..	July 1934.
14	7	26th Jan. 1934 to 28th Mar. 1934.	1	..	Sept. 1934.
14	14	1st Aug. 1934 to 31st Aug. 1934.	1	..	Oct. 1934.
14	14	1st Oct. 1934 to 31st Oct. 1934.	1	..	Mar. 1935.
			1	..	June 1935.
112	70		12	..	

This result definitely confirms the infection by above ground agency. This has further indicated 2 possible seasons of infection, one in March to May and the other in August to October. The experiment is being continued to narrow down the seasons to specific months.

In this experiment the period between exposure to infection and manifestation of the disease varied from 2 to 9 months, the average time being 6 months.

(iv) *Mass infection cages*.—Two mass infections were started in May 1934 at Denkanikota and in August 1934 at Javalagiri.

The cage at Denkanikota is situated in a spike-free area 4 miles away from the centre of insect collection whereas the Javalagiri cage is situated right in the midst of a heavily spiked area. The insects were collected between 9 p.m. and 5 a.m., classified and counted by types, and released in these cages.

In December 1934 a fresh batch of 23 healthy sandal plants was introduced into the Javalagiri cage.

On 19th January 1935 one of the healthy plants in the cage at Javalagiri looked suspicious and subsequently exhibited the characteristic symptoms of spike. Material from this plant was taken on 19th February 1935 to Denkanikota and utilised for grafting 6 healthy plants, two of which developed the disease on 28th May 1935, thus confirming that the spike symptoms produced through the agency of insects were transmissible by grafting as in the case of natural spike. On 8th March 1935 two more plants in the Javalagiri cage showed the disease.

It was thought that other plants in the cage might be masking the disease and it was decided to remove 50 per cent. of the plants from the cage and prune them. Accordingly 28 plants, 15 from the plants put in the cage in August 1934 and 13 from those introduced in December 1934, were defoliated on 9th March 1935 and removed to Denkanikota healthy locality. These plants were immediately replaced in the Javalagiri cage, by another set of healthy plants. About the middle of April 1935, 5 plants among the defoliated and 8 among the plants that were left in the cage, all belonging to the series of plants kept in the cage in August 1934 got spiked. Of the remaining plants of the August 1934 series, one more showed the disease in September 1935 thus bringing up the total to 17 out of 37 plants or nearly 46 per cent.

In the Denkanikota cage, one plant got the disease in August 1935. By the time the first manifestation of spike took place, insects relating to 265 types had been introduced into both the mass infection cages. It was therefore decided to introduce no more types after this as the experiment indicated that at least one of the vectors (if there be more than one) must be among the 265 types.

*The experiment definitely establishes the insect vector theory of spike disease.*

(v) *Compartment cages*.—The 265 types of insects introduced were classified with the help of an Entomologist (Mr. Mahdihassan of the Indian Institute of Science, Bangalore) into five groups, viz., (1) Jassidae, (2) Pentatomidae, (3) Fulgoridae, (4) Locustidae, (5) Beetles, etc., and the numerical strength of each which had been released in each cage compared. As a result of the comparison, insects of the families of Jassidae, Fulgoridae, Pentatomidae, were found important. These three families are also suspected together with 7 others suggested by Dehra Dun and published on page 5, part 1, Vol. XX of the *Indian Forest Records*. To test these families separately, a compartment cage—30'×6'—was opened with 5 rooms—5'×6' each—at Javalagiri, an infected area—in February 1935, each room was stocked with spiked and healthy sandal plants and insects of the types tabulated below were released in each, from the night collections.

*Compartment No. I—Jassidae*.—13 types.

*Compartment No. II—Pentatomidae*.—25 types.

*Compartment No. III—Fulgoridae and Coreidae*.—26 types.

*Compartment No. IV—Locustidae*.—16 types.

*Compartment No. V—All other types*.

The total number of insects released in these rooms during the year is tabulated below :—

Room No.	Family of insects.	Total number of insects released till end of 31st March 1936.
I	Jassidae . . . . .	2,345
II	Pentatomidae . . . . .	3,135
III	Fulgoridae and Coreidae . . . . .	2,125
IV	Locustidae . . . . .	1,875
V	All other insects . . . . .	2,866

Though a large number of insects was released in each cage the survivals after a few days were not a quarter of the number released. No spike has been transmitted in these cages from sandal to sandal, but in October 1935, one *Scutia indica* plant in the room No. 3 developed a spike-like appearance.

In September 1935, another compartment cage with five rooms was constructed, also at Javalagiri. Healthy and spiked plants were put in this cage and the types of insects released are given in the statement below :—

Room No.	Nature of insects released.	No. of types.	No. of insects released till 31st March 1936.
I	Day insects not so far found in night collections.	5	162
II	Insects above the 265 types caught at night	10	267
III	Beetles collected in day time (also found at night).	5	413
IV	Locustids caught in day time (also found at night).	8	1,658
V	All other insects . . . . .	..	7,997

No case of transmission has taken place in this cage.

With the idea of duplicating the group transmission experiments another cage with 5 rooms was erected at Denkanikota in December 1935. In room No. 1, Jassids have been introduced and in room 2, the Pentatomids.

*Transmission experiments with individual species.*—(i) With the idea of narrowing down the range of suspected vectors individual species were selected.

*Group A.*—Comprises insects suspected by Dehra Dun and consists of *Petaloccephala*, *Acropona*, *Bythoscopus* and *Moonia* of Jassidae, *Catantus incarnatus* of Pentatomidae, and *Sarima*, *Tambinia* and *Eurybrachys* of Fulgoridae, and *Otinotus* of Membracidae.

*Group B.*—

*Pentatomidae.*—5 Types.

*Jassidae.*—3 Types.

*Fulgoridae.*—2 Types selected on other evidence.

*Group C.*—Two types of Pentatomids, and one type of Membracids.

No case of transmission has been obtained in any of these experiments so far.

(ii) *Experiments to find the chief plant food of individual species.*

In order to find the chief food-plants of various types of insects an experiment was devised in 1935 by which 5 insect types were enclosed in sleeves on various plants and their preferences have been recorded.

*Specific Vector Experiments.*

Started on 1st September 1935. Insects were fed on diseased sandal for varying periods and then transferred to healthy sandal. The feeding was done by enclosing the insects in sleeves.

Type of insect.	Duration of feeding.	No. of insects for each period.	Period after transferring the spike fed insects to healthy sandal.	Condition of sandal plants.
No. 4 .	1 to 6 days at intervals of every 24 hours.	10 insects each time.	4 months .	Healthy.
No. 18 .	1 to 15 days at intervals of every 24 hours.	Do. .	6 months .	Do.
No. 24 .	Do. . . . .	Do. .	4 months .	Do.
No. 19 .	1 to 9 days at intervals of every 24 hours.	Do. .	6 months .	Do.
No. 238 .	1 to 9 days at intervals of every 24 hours.	Do. .	3 months .	Do.
No. 96 .	1 to 11 days at intervals of every 24 hours.	Do. .	4 months .	Do.

With the above types of insects, no transmission has been obtained so far.

*Experiment to find out whether infection takes place in the night or day.*—The results in the Javalagiri mass infection cage pointed out that the vector occurs during the night, and in order to get more data regarding the time of infection, an experiment was started at Aiyur on 24th May 1935. 8 Platforms were constructed each at a height of 8 feet from ground-level. 32 potted healthy sandal plants raised at Denkanikota Potculture plot were transported and placed on the platforms at 4 plants to each—2 plants on each platform were caged in day time, and just at dusk the cages from these are removed and put on the other two which are kept exposed during day time. At the end of every two months, the plants are taken to Denkanikota Potculture plot and fresh batches are brought and kept on platforms and experimented with.

The experiment was started on 24th May 1935 and the first set was removed on 31st July 1935. So far (*i.e.*, till the end of March 1936) four more sets have been kept and removed.

One plant among those exposed during the day between 24th May 1935, and 31st July 1935 and another among those exposed during the day between 30th September 1935 and 30th November 1935, manifested the disease indicating the possibility of infection during day time.

#### PUNJAB.

*Hoshiarpur division.*—The locust attack was not severe or widespread but mild and confined only to the outer boundary of Karnapur reserve adjoining the fields. Favourable heavy showers combined with prompt measures taken in co-operation with the Agricultural Department destroyed the insects.

## CHAPTER V.

### UTILIZATION AND ECONOMIC RESEARCH

#### ASSAM.

#### I.—GENERAL WORK OF ADMINISTRATION.

Mr. S. M. Deb, Extra Assistant Conservator of Forests, held charge of the post of Forest Utilisation Officer from the 1st July 1935.

#### II.—EXPERIMENTAL ACTIVITIES.

##### (1) *Wood Technology.*

The study of variation of quality with locality and size of the following species was taken up during the year :—

*Hollong (Dipterocarpus macrocarpus).*

*Simul (Bombax malabaricum).*

##### (2) *Timber Seasoning.*

Special circumstances under which kiln-seasoning is worth consideration seem to have arisen in Surma Valley Saw Mills who have, therefore, been recently advised to add to their equipment a seasoning kiln.

##### (3) *Timber Testing.*

Samples of *ajhar (Lagerstræmia flos-reginæ)* and *bonsum (Phæbe goalparensis)* were sent to Mr. Richard Mueller's Shuttle Works, Bombay, for a shuttle-making test. No report is yet to hand.

Two pieces of *bhe (Salix tetrasperma)* were supplied to the Eastern Merchants of Calcutta for ascertaining its suitability for pencil making at the Madras Pencil Factory. The test report has not yet been received.

The following twelve species were supplied to the Gramophone Company of Dum-Dum, Calcutta, for test, to find out woods suitable for the manufacture of Gramophone Cabinets :—

*Adina cordifolia.*

*Albizzia procera.*

*Amoora wallichii.*

*Chukrasia tabularis.*

*Duabanga sonneratioides.*

*Gmelina arborea.*

*Lagerstræmia flos-reginæ.*

*Lagerstræmia parviflora.*

*Michelia champaca.*

*Phæbe goalparensis.*

*Schima wallichii.*

*Terminalia myriocarpa.*

The Cabinet Factory Superintendent of the Company reports that it will be sometime for the results of the experiment to be out.

Preliminary steps were taken for testing *makai* (*Shorea assamica*), *titachapa* (*Michelia champaca*), and *ahoi* (*Vitex peduncularis*) for umbrella handles, and *sam* (*Artocarpus chaplasha*), *ajhar* (*Lagerstræmia flos-reginæ*), *gurjun* (*Dipterocarpus turbinatus*) and *tarakhapa* (*Adina cordifolia*) for jute mill bobbins.

#### (5) Wood Working.

The following report on the working qualities of *Carallia integerrima* (kiln dry) under Project I, was received during the year from the Forest Research Institute, Dehra Dun :—

“The specimen under review was straight-grained and free from defects of any kind. It converted without difficulty and behaved exceptionally well during machining processes, a fine finish being obtained with little or no effort. It turned well and took an excellent polish.

The timber appears to be suitable for general interior work, cabinet-making, flooring, etc., and also for small work such as brush backs, handles, etc.”

Power-machine turned *gurjun* (*Dipterocarpus turbinatus*) made excellent tool handles in Surma Valley Saw Mills, whose samples were so satisfactory as to secure for them a contract of 10,000 handles from the East Indian Railway, through Messrs. Gladstone Wyllie & Co., of Calcutta.

*Makai* (*Shorea assamica*) has been found highly suitable for utility plywood and *sapas* (*Michelia* spp.) for decorative and ornamental veneers; and the Assam Railways and Trading Company's veneer mill at Margherita is utilising as much as of these species as is procurable for the purpose.

Surma Valley Sawmills are successfully making cabinets for gramophones and radio sets with *Chukrasia tabularis*, *Artocarpus chaplasha* and *Alseodaphne owdenii*.

*Michelia champaca* and *Phæbe goalparensis* have proved to be ideal woods for iron foundry work. The Tata Iron and Steel Co. use them extensively.

*Mesua ferrea* treated with light mahogany varnish makes electric light stands suitable for use in bed or other rooms.

*Alseodaphne owdenii* and *Michelia champaca* are steadily gaining in popularity for the manufacture of decorative furniture of a high order, and very ornamental panels.

### *Plywood and Veneers.*

The veneer mill at Margherita used more than two lacs of cubic feet of *hollong* (*Dipterocarpus macrocarpus*) in the round, for plywood for boxes and utility work, besides a fair amount of *makai* (*Shorea assamica*) for the same purposes, and *sapas* (*Michelia* spp.) for decorative plywood and ornamental veneers.

The Assam Sawmills and Timber Co., Ltd., confined themselves to the use of *hollock* (*Terminalia myriocarpa*) for their huge requirements of tea chest plywood. The following report from the Manager, on the utility of *Chukrasia tabularis* from the Sadiya Frontier Tract, for decorative plywood, is of interest:—

“The *Chukrasia* found locally is not very suitable for conversion into plywood as owing to patches of interlocked fibres large sheets of first class quality veneer cannot be obtained in any quantity. Small sheets can be obtained but there is no demand for panels less than 3'×3'—usually enquiries are for sheets 4'×4' ”.

### *Paper Pulp.*

The India Paper Pulp Co., Ltd., took 2,000 tons of dry splits of the following bamboos for the manufacture of paper pulp, from the Surma Valley, of which about 75 per cent. was removed from Government forests and the rest from private sources—mainly tea grants:—

*Muli* (*Melocanna bambusoides*).

*Pecha* (*Dendrocalamus hamiltonii*).

*Khang* (*Dendrocalamus longispathus*).

### (7) *Minor Forest Produce.*

*Gandhi* (*Homalomena rubescens*).—20 lbs. of root were sent to Col. R. N. Chopra of the School of Tropical Medicine, Calcutta, for medicinal test; and the Forest Economist, Dehra Dun, also advised that it be included in the triennial programme of the Forest Research Institute.

*Ahoi* (*Vitex peduncularis*).—20 lbs. of leaf were sent to the School of Tropical Medicine, Calcutta, for purposes of analysis and investigation and 80 lbs. of each of leaf and root to the Forest Research Institute, Dehra Dun, for the same purpose. The decoction from the leaf has been found very efficacious in the treatment of blackwater fever.

*Indian rubber (Ficus elastica).*—3½ lbs. of latex were supplied to one firm of Calcutta for quality test, and another took several maunds on a permit. This product which completely lost ground some two decades ago, seems to be coming into slight demand. It is suitable for the manufacture of cheap rubber shoes and low quality tyres and tubes.

Arrangements for the test of leaves of this as well as of several other species, to find out their suitability for wreath-making, by the British Legion Poppy Factory Ltd., of Surrey, are in progress. Leaves of *kathalchapa (Michelia mannii)* promise well for the purpose.

*Nahor (Mesua ferrea).*—For industrial research, samples of seeds were supplied to :—

(1) Principal, Sir Harcourt Butler Technological Institute, United Provinces, Cawnpore . . . . .	½ ton.
(2) Bengal Chemical and Pharmaceutical Works, Calcutta . . . . .	20 lbs.
(3) Godrej Soap Limited, Bombay . . . . .	14 "
(4) Anandji Virji & Co., Bombay . . . . .	5 "
(5) H. Karai, Bombay . . . . .	5 "
(6) Malic Soap Factory, Gauhati . . . . .	10 "
(7) B. Bhattacharjee, Gauhati . . . . .	1 "
(8) P. Ramaswami Ayyar, Bangalore . . . . .	10 "
(9) Bombay Soap Factory, Bombay . . . . .	5 "
(10) The Tata Oil Mills Co., Ltd., Bombay . . . . .	5 "

Below are given the results of tests :—

*Analysis of seeds on nahor (Mesua ferrea) and oil from the seeds.*

(1) By the Tata Oil Mills Co., Ltd.—

	Per cent.
" Seeds—Husk . . . . .	32
Kernel . . . . .	68
Moisture . . . . .	7.2
Ether Extract . . . . .	54.4
Contents of the Ether Extract :—	
Saponification value . . . . .	200
I. Value . . . . .	86
Titre . . . . .	33.4cc.

(2) By the Bengal Chemical and Pharmaceutical Works Ltd., "The oil content of the seeds is about 75 per cent. and the oil has a high saponification value (about 200) and is consequently suitable for soap-making."

(N.B.—Presumably the word "seeds" means kernel).

(3) Mr. Athawalle, Industrial Chemist, Sir Harcourt Butler Technological Institute, Cawnpore (United Provinces), says that the seeds contain an oil which would be very suitable for soap-making.

(4) By the Imperial Institute, London, and several others (as supplied from the Forest Research Institute, Dehra Dun)—

	Samples.	
	I	II
Sp. gr. at 50 . . . . .	.935	.932
Solidifying point of fatty acids . . . . .	..	30.5
Acid value . . . . .	20.1	16.2
Saponification value . . . . .	204.0	204.9
Iodine value . . . . .	90.0	92.2
Hehner value . . . . .	..	91.9
Unaponifiable matter . . . . .	..	1.5%

(5) Extract from a letter from the President, Forest Research Institute, Dehra Dun :—

“ This oil has also been investigated by Grimme (Chem. Rev. (1910), 17,180), Dhingra and Hilditch (Jour. Soc. Chem. Ind. (1931), 50, 9T). The oil has been found to consist of the glycerides of myristic, palmitic, stearic and oleic acids and unsaponifiable matter.”

### (8) Commercial Activities.

#### (a) SUPPLY OF TIMBER TO RAILWAYS.

##### 1. Sleepers.

##### (i) *Sal* (*Shorea robusta*).

*Departmental.*—Orders for the supply of the following metre-gauge sleepers were received during the year from the Sleeper Control Officer, Eastern Group :—

Year.	Nos. of sleepers.	Rate per piece.	Total value.
		Rs. A. P.	Rs. A.
1936-37 . . . . .	50,000	2 2 0	1,06,250 0
1937-38 . . . . .	50,000	2 2 6	1,07,812 8
1938-39 . . . . .	50,000	2 3 0	1,09,375 0

*Purchasers' Agency.*—The following table shows the numbers of sleepers to be supplied to the group from Assam forests within the same triennium :—

Year.	Broad gauge.	Metre gauge.	Rate per piece.
1936-37 . . .	30,000	91,500	{ B. G. Rs. 4-8-0 to Rs. 4-10-0 M. G. Rs. 1-15-0 to Rs. 2-4-0
1937-38 . . .	69,500	144,500	{ B. G. Rs. 4-10-0 to Rs. 4-10-6 M. G. Rs. 1-15-0 to Rs. 2-4-0
1938-39 . . .	74,500	125,000	{ B. G. Rs. 4-10-0 to Rs. 4-11-0 M. G. Rs. 1-15-0 to Rs. 2-4-0

During the year under report the following sleepers were supplied and Messrs. Himatsingka Timber, Ltd., were responsible for more than 80 per cent. of the supply :—

Broad Gauge . . . . .	60,000
Metre Gauge . . . . .	200,000
Crossing . . . . .	30,000
Broad Gauge (Rejected) . . . . .	3,000
Metre Gauge (Rejected) . . . . .	25,000

(ii) *Nahor (Mesua ferrea).*

The Assam Railways and Trading Co., Ltd., have decided to draw in full their annual requirements of sleepers, which are in the vicinity of 20,000 pieces, from local *nahor*.

(2) *Timber other than sleepers.*

*Departmental.*—Only 133 c.ft. of *sal* scantlings were supplied to the Assam Bengal Railway.

*Purchasers' Agency.*—A very large quantity of *hollong* (*Dipterocarpus macrocarpus*) and *gurjun* (*Dipterocarpus turbinatus*) was supplied to the East Indian Railway against last year's contract. Competition has brought down the price to such low levels as to leave no profit, in view of the heavy rejection of squares, which when supplied in green conditions, crack badly; hence last year's suppliers have refused to submit tenders till matters improve. 10,000 c.ft. of *bonsum* (*Phæbe goalparensis*), *titachapa* (*Michelia champaca*) and *amari* (*Amoora wallichii*), and also 25 *sal* baulks for durability test in salt water at the Chittagong jetties, were supplied to the Assam Bengal Railway.

## (b) GENERAL.

Services of advice and assistance in the matter of selection and supply of their requirements of woods were offered to the Executive Engineers, Public Works Department, and Chairmen, Local Boards. In response came orders for a small consignment of *bonsum* from the Executive Engineer, Western Assam division, which was satisfactorily supplied through a contractor.

## (c) MINOR FOREST PRODUCTS.

*Bamboos*.—Owing to the cheapness at which the Titaghur Paper Mills Co., Ltd., are getting large supplies of cultivated bamboos from the vicinity of their mills, there is little hope for revival of this trade with them in the near future. Consumption by the Indian Paper Pulp Co., Ltd., is again decreasing gradually because of the competitive lower cost of supplies from elsewhere. There are immense possibilities of bamboos in the Surma Valley which also offers good sites for paper mills either within or just outside; with the object of finding a party who would set up a mill, these ideal conditions are being circulated in probable quarters. The umbrella handle industry made a great stride during the year, and thin pieces of *muli* (*Melocanna bambusoides*) were sold by the producers at Rs. 9 to Rs. 12 per thousand against Rs. 5 to Rs. 7 last year.

*Cane*.—The trade in cane in Bengal and Assam is virtually Assam's monopoly, except that a very feeble fraction of only Calcutta's consumption comes from Malaya. *Malacca* cane is too costly for general purposes such as colliery, factory, manure and plucking baskets. Had it not been for the recent cutthroat competition and lack of unity among the distributors, the outlook of the trade would have been much brighter. Now that the financial prospects of the coal and tea industries are improving, this trade is surely one in which, with combination in working, all concerned can make a reasonable profit without any harm to the consumers; with this object in view, correlated organisation of sales is being attempted.

*Ivory*.—17 *maunds*, 20 *seers* and 13 *chattacks* of found elephant tusks were sold by auction for Rs. 6,687. The average price per *seer* came to Rs. 9-8-6 against Rs. 7-13 received at the previous auction, resulting in an increase of Rs. 68-12 per *maund* over the last sale. This improvement in value may be attributed to the wider advertisement of the sale.

*Rhinoceros horns and hoofs*.—Of three recovered *rhino* horns, one weighing 10½ *tolas* was sold for Rs. 80 and the rest weighing 110½ *tolas* fetched Rs. 310 only, as both of them were worm-eaten and almost useless. Six ounces of hoofs or nails fetched Rs. 6,     /     /     /

## (e) TIMBER TRADE.

*Import.*—The following is an account of the import of foreign timber via Chittagong Port :—

1933.	1934.	1935.
Tons.	Tons.	Tons.
863	1,439	1,656

Some portions of these quantities came to Assam, which is so replete with woods as to more than satisfy her timber requirements of all descriptions.

*Export.*—Export to Bengal consisted of *sal* (*Shorea robusta*) about 18,000 tons, *simul* (*Bombax malabaricum*) and *bhelu* (*Tetrameles nudiflora*) about 5,000 tons, *bonsum* (*Phæbe goalparensis*), *amari* (*Amoora wallichii*), *gogra* (*Schima wallichii*) and *titachapa* (*Michelia champaca*), *sam* (*Artocarpus chaplasha*), *jarul* (*Lagerstræmia flos-reginæ*), etc., about 6,000 tons and to Bihar *bonsum* and *titachapa* 100 tons.

## (9) Miscellaneous.

*Artificial propagation of Nux-vomica.*—Consequent upon the recommendation made by the Indian Drugs Enquiry Committee, 1930-31, regarding the cultivation of medicinal plants and herbs, a survey was undertaken to ascertain the occurrence and commercial possibilities of such plants and herbs. Only a few very small patches of *Strychnos nux-vomica* trees have been traced in the Assam Valley, which are incapable of yielding as much as is locally required for the treatment of cattle diseases including mostly general debility of elephants and buffaloes (both of which abound in the valley), and the price at which the imported stuff is ordinarily sold is exorbitant. Plantations have therefore been started in three Divisions.

*Collection of specimens and supply of samples.*—With a view to opening a Museum of indigenous forest products of economic importance, collection of specimens is in progress. Requests for samples were complied with; also specimens for trial for commercial and industrial development were liberally distributed.

*Enquiries.*—Various enquiries were answered on timber, bamboos, cane, lac, gum, fibre, Indian rubber, resin, honey, bees' wax, fish-poisons and drugs.

*Liaison.*—The usual liaison was maintained with the specialists at the Forest Research Institute, Dehra Dun. Acknowledgments for help are due to them and particularly to Capt. H. Trotter, I.F.S., Forest Economist, to whom the Forest Utilisation Officer feels personally indebted for his continued and invaluable advice.

## BENGAL.

## UTILIZATION.

## I.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Utilisation Officer, Bengal, was held by Mr. T. M. Coffey, Deputy Conservator of Forests, from 1st April 1935 to 31st May 1935, and by Mr. C. T. Trigg, Deputy Conservator of Forests, from 1st June 1935 to 31st March 1936.

The question of making the post of Forest Utilisation Officer permanent was again considered by Government in November 1935, and it was decided that the post should be made permanent and that the office should be situated in Calcutta.

## II.—EXPERIMENTS AND RESEARCH.

1. *Wood Technology.*

One sample of *malagiri* (*Cinnamomum* spp.) was sent to Dehra Dun from Kalimpong division during the year and was identified as *C. ceccidodaphne* or possibly *C. glanduliferum*. Further samples will be sent together with specimens of flowers and fruits.

2. *Timber Seasoning.*

(i) *Cedrela toona*.—10 tons of forest-grown *toon* were sent to Dehra Dun for kiln-seasoning tests for comparison with road-side *toon*. No report has yet been received.

(ii) *Girdling teak in Chittagong Hill Tracts*.—No report has yet been received on the trees which were girdled in Sitapahar range in 1933-34.

3. *Timber Testing.*

(i) Logs of the following species were sent to Dehra Dun during 1934-35 for test on Project VIII:—

<i>Cryptomeria japonica</i>	.	.	.	.	.	.	Darjeeling.
<i>Bucklandia populnea</i>	.	.	.	.	.	.	Do.
<i>Castanopsis hystrix</i>	.	.	.	.	.	.	Do.
<i>Terminalia tomentosa</i>	.	.	.	.	.	.	Kurseong.
<i>Anthocephalus cadamba</i>	.	.	.	.	.	.	Do.
<i>Artocarpus chaplasha</i>	.	.	.	.	.	.	Chittagong Hill Tracts.
<i>Gmelina arborea</i>	.	.	.	.	.	.	Do.
<i>Lagerstræmia flos-reginæ</i>	.	.	.	.	.	.	Do.
<i>Michelia champaca</i>	.	.	.	.	.	.	Do.
<i>Dipterocarpus turbinatus</i>	.	.	.	.	.	.	Do.

(ii) *Alnus nepalensis*.—A sample of this timber was sent from Darjeeling division in 1932-33 and the following report has since been received :—

" This species was received for test from the Darjeeling division, Bengal, through the Forest Utilisation Officer, and has been tested under our Project 1. All the tests have now been finished both in the green and air dry condition. The results of tests are attached herewith.

The wood is very light in weight being roughly about half the weight of teak in the seasoned condition. The strength is also roughly about half that of teak in static bending and compression parallel to grain, about two-thirds of teak in impact bending, and less than a third in compression perpendicular to grain and hardness. It cannot, therefore, be used for any constructional work but it can be put to numerous uses which do not demand much strength and hardness but for which light weight, appearance and easy workability are essential."

The Officer in charge, Wood Workshops, reports that, " The wood machines and turns well to a smooth and satin-like finish. It stains and polishes well, and would be suitable for furniture, fittings, possibly radio and gramophone cabinets, matchhoarding, ceiling boards, partitions, etc. "

The Officer in charge, Seasoning Section, reports that the timber is extremely easy to dry.

" 1" thick planks can be dried in 3 days from the green condition to about 8 per cent. moisture content without any increase in degrade.

The keeping qualities of the timber are also expected to be good as the figure for its ' retention of shape ' is about 76 per cent. of teak.

Selected material is therefore worth while trying for the various purposes suggested above."

(iii) *Grewia tilaefolia*.

*Grewia vestita*.

Samples of these timbers were sent to Dehra Dun in 1934-35 from Kurseong division for comparative tests.

	Logs.
(iv) <i>Gmelina arborea</i> . . . . .	4
<i>Artocarpus chaplasha</i> . . . . .	4
<i>Dipterocarpus</i> spp. . . . .	4
<i>Michelia champaca</i> . . . . .	4

Sample logs of the above four species were sent to Dehra Dun for general quality tests in 1934-35 from the Chittagong Hill Tracts division.

(v) *Tectona grandis*.—5 logs with 5 discs taken from different positions in the tree were sent from Kurseong division and 5 logs with

5 discs from trees which had been girdled were also sent from Chittagong Hill Tracts division for comparative tests.

(vi) *Dalbergia sissoo*.—The following report has been received from Dehra Dun on the logs sent in 1934-35 from Jalpaiguri division for test under Project 1.

*Project No. 1—Consignment No. 202 (air-dry).*

“The specimen under review was a rich dark colour very suitable for furniture, panelling and veneer work.

“It was somewhat below normal in the matter of hardness, but was straight-grained, and it machined and worked up beautifully with very little effort.

“The pores were on the large side but an application of filler made the specimen quite suitable for polishing.

“It was the easiest piece of sissoo I ever worked.”

*Project No. 1—Consignment No. 202 (kiln dry).*

“This specimen was of a rich dark brown colour very suitable for high class furniture and panelling work. We had no difficulty in converting and machining the material which was easily brought up to a very fine polish finish by hand. There were narrow straight lines of interlocked fibres which were inclined to pick out during the machining process but a little hand planing and scraping soon removed the defect.

“This timber makes up into a very fine veneer and plywood and is also useful for building work, coach and cart work, wheel-wright work and many other purposes including bending”.

(vii) *Ailanthus grandis*.—A specimen log of this species was sent to Dehra Dun in 1934-35, from Buxa division for tests under Project I.

During the year under report the following species have been sent for test and trial :—

(viii) *Morus indica*.—6 logs from Jalpaiguri division to Dehra Dun.

(ix) *Teak*.—2 pieces of Kaptai teak were sent to Dehra Dun.

(x) *Tetramales nudiflora*.—1 wagon load was sent from Buxa division to the Goalpara Timber Co.

(xi) *Polyalthia simiarum*.—A sample of this species was sent to the Western India Match Co., for test from Buxa division, but was found unsuitable.

#### 4. Wood Preservation.

*Acrocarpus fraxinifolius*.—No report has yet been received on the 200 treated sleepers of this species which were laid down in the line by Executive Engineer, Katihar, Eastern Bengal Railway, in 1933.

5. *Minor Forest Products.*

(a) *Gurjun oil*.—Experiments in the departmental tapping for *gurjun* oil in Chittagong division are in progress, and figures are being collected.

(b) A sample tin of *gurjun* oil was supplied to the Director of Industries, Bengal, from Chittagong division in 1933-34 for test as to its suitability for paint manufacture but no report has yet been received.

(c) *Saw dust*.—Samples of *Cryptomeria japonica* and *Sterculia villosa* were supplied to the Lightfoot Refrigeration Co., Ltd., for test in 1934-35 by Darjeeling and Buxa divisions respectively. The preliminary tests on the saw dust gave fairly satisfactory absorption and evaporation figures. The final report states "The wood, in the form of saw dusts of various grades of fineness, was tested for absorption of liquid oxygen and the rate of evaporation in free air examined. The absorptive figure was relatively high, but retentivity was rather poor, which is probably due to the wood structure".

"The tests showed that no particular advantage could be gained by using woods of this type in preference to say *semul* wood which can be obtained locally."

6. *Paper Pulp.*

Semi-commercial tests were carried out at Dehra Dun on the following species of bamboos :—

Particulars.	<i>Dendrocalamus hamiltonii.</i>	<i>Oxytenanthera auriculata.</i>
1. <i>Predigestion</i> .—Duration (from the time pressure begins to rise) and temperature of cook.	2 hours at 115°C	2 hours at 115°C.
2. <i>Final digestion</i> .—Duration (from the time pressure begins to rise) and temperature of cook.	3 hours at 148°C	$\frac{1}{2}$ hour at 153°C and 2 $\frac{1}{2}$ hours at 148°C.
3. Parts of alkalies used per 100 parts of the raw material (air-dry)—		
Caustic soda . . . . .	12	12
Sodium sulphide . . . . .	6	6
4. Percentage yield (air-dry) on unbleached pulp on the raw material (air-dry).	47	45
5. Parts of standard bleaching powder used on 100 parts unbleached pulp (air-dry).	12.7	14.2
6. Percentage yield (air-dry) of bleached pulp on the raw material (air-dry).	42.3	41.3
7. Average fibre length in mm. . . . .	3.4	3.5

The conclusions arrived at are that the above two species compare very favourably with other species now in use, and that they could be used for the commercial manufacture of pulp or paper if available at economic prices.

### 7. Tans.

No reply has yet been received on the *goran* (*Ceriops roxburghiana*) bark sent to Hamburg and Denmark.

### 8. Wood Working.

i. No report has yet been received on the specimen *sal* sleepers sent to the Sudan and Ceylon.

ii. *Picker arms*.—Samples of *Dalbergia sissoo*, *Heritiera minor*, *Dipterocarpus turbinatus* and *Morus laevigata* were sent to the Birla Jute Mills as picker arms in 1934-35. A preliminary report of December 1934, stated that the arms were still working and that no further report could be given until they gave way. No further report has been received yet.

iii. *Pestles and mallets*.—Samples of *Heritiera minor* were sent in 1934-35 from the Sundarbans to the Superintendent, Presidency Jail, for test. The pestles made from the logs appear satisfactory, as there was very little cracking and no appreciable wear. It is possible that an order may be obtained at the termination of the current contract.

This timber was, however, found unsuitable for mallets as they both cracked and broke at the handle.

iv. *Hammer handles*.—30 samples of timber were supplied to the E. B. Railway in 1934-35 of which four only, namely :—

*Bucklandia populnea*

*Betula* spp.

*Quercus thomsonii*

*Quercus acuminata*

were selected for test. None was found satisfactory.

v. *Boat building*.—*Tectona grandis*. Teak from Bamonpokri in Kurseong was sent to the Sundarbans in 1934-35 for trial, the final report has not been received yet.

vi. *Cedrela toona*.—*Toon* from Buxa was sent to the Sundarbans for trial. It was found unsuitable as it was attacked by marine borers, within 2 months, in spite of being painted with coal tar. Experiments after painting with, and soaking in, Ascu are being suggested.

vii. *Life saving apparatus*.—Samples of *Cryptomeria japonica* and *Sterculia villosa* were sent to the Principal Engineer and Ship Surveyor for test, the timbers were found unsuitable.

viii. *Specimen panels*.—Logs of *Carapa moluccensis* were sent to Dehra Dun for the preparation of specimen panels.

ix. *Limber shafts*.—Samples of *Amoora wallichii* were sent from Buxa to the Gun Carriage Factory, Jubbulpore, for test as a substitute for sal. No report has been received yet.

x. *Pencils and penholders*.—Specimens of *Carapa moluccensis*, *Amoora wallichii*, *Sonneratia apetala*, and *Aegieras majus* were sent to F. N. Gooptu & Co., for test but were found unsatisfactory.

### 9. Miscellaneous.

(i) *Pneumatic equipment for bullock carts*.—One cart equipped with Dunlop pneumatic tyres was tried out in Jalpaiguri division with fairly satisfactory results. The outfit has now been sent for further test to Buxa division.

There is no doubt that a cart with this equipment can carry far bigger loads, both of timber in the round, or sawn timber, than the ordinary country cart and also that journeys can be done in a far shorter time. Certain difficulties were experienced in loading, as the carters were unable to carry out their usual method—i.e., turning the cart upside down on top of, and fastening it to the log and then levering the cart on to its wheel again.

It was also found that there was insufficient clearance for working in normal clear felling coupes from which the stumps had not been removed.

There is also the danger of the tyres riding up over a branch or stump and coming down on a sharp stump of brushwood, resulting in a puncture, although this did not actually occur.

The difficulty in loading, will I think, not cause much trouble as it should not be difficult to devise and teach the carters some other system of loading. For work in areas from which stumps have not been removed it may be necessary to use a "Sling Cart" such as is being used in the forests of Burma and Madras.

The liability to puncture on sharp stumps of brushwood is alone likely to cause any trouble.

(ii) The usual liaison was maintained with the Divisional Forest Officers, Timber Advisory Officer to the Railway Board, Timber Advisory Officer to the High Commissioner and the Forest Research Institute, Dehra Dun.

## BIHAR AND ORISSA.

## UTILIZATION.

## I.—GENERAL WORK OF ADMINISTRATION.

The Forest Research Officer, who from December 1935 was also the Working Plans Officer, held charge of the Utilisation Branch. He was assisted by the Utilisation Ranger, whose post was temporarily sanctioned for one year. It has since been extended for five years. They continued to act as a link between contractors and consumers.

## II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

(2) *Grading Rules*.—In order to prevent disputes as to quality, it has been found necessary to draw up grading rules for different classes of timber, and these are under preparation. The Empire hardwood grading rules for sawn timber have been studied, and also the grading rules for teak squares drawn up by the Forest Research Institute, Dehra Dun, and the Burma specifications for logs. It is hoped to reconcile the somewhat conflicting values of defects given in these rules and to produce values which can apply to logs, squares and sawn timber. A standard agreement form has also been drawn up to be binding on both contractor and purchaser.

(3) *Reduction in freights*.—Representations were made to the B. N. Railway authorities that the present freight on *sal* poles only permitted extraction with royalty to us within a radius of five miles, or ten miles if royalty was foregone. The Company have now introduced a sliding scale with reduced freights for the longer leads, which allows extraction up to a fifteen mile lead, with a small royalty to us at that distance. As a result, the thinning schemes of Kolhan and Porahat will receive much needed encouragement.

(4) *The Patna exhibition*.—The decision to take part in the Patna exhibition marked a definite stage in our utilisation and marketing policy. The exhibits took six months to prepare and collect, though a visit to Dehra Dun in September was of inestimable value in helping to decide what to exhibit. Thirty-three species in plank form constituted the major products section. Bamboos and *sabai* grass, paper pulp, hamboo furniture, toys, matchwood veneers and manufacture, gums, resins, tanstuffs, dyes, oils, herbs and drugs also all found a place. Furniture occupied the centre of the stall. Dehra Dun sent a laurel veneer screen admired by all, bits of furniture, veneer samples and how they were built up, tool handles of *dhaura* (*Anogeissus latifolia*) and hickory, posters on seasoning of timber, a wood preservation section, a chart showing strengths of Indian timbers which aroused much interest, paintings of silvicultural systems, entomological and botanical exhibits.

(5) Laurel aroused so much interest that it has been considered advisable to season this wood carefully to satisfy the anticipated demand.

(6) Silver medals were awarded for timbers, the laurel screen, paper manufactures, and an inlay ebony cupboard, and certificates of merit for cutch, and wooden inlay sandals.

(7) The exhibition afforded a valuable means of getting in touch with people and as an advertising medium. We have now an interesting collection of exhibits which are being added to from time to time. It is hoped to exhibit in other centres as opportunity arises.

(8) *Publicity and propaganda*.—These play an important part in the utilisation policy. With the help of the Government Publicity Officer, in the local and all Indian press the attention of the general public has been drawn to (1) the merits of the Ascu preservative, (2) the possibilities of treated wood for bridges and earthquake proof buildings, (3) the Forest stall at the Patna exhibition, (4) the utility and the economic products of the forests of Bihar and Orissa, and (5) the irrigation scheme at Bamiaburu as a specific for flood problems. Engineers and the Members of the Legislative Council have also received appropriate literature, while a lecture was delivered at the Science College, Patna, on "Erosion" during the exhibition period.

### *Summary of Results.*

(9) Sixty tons of laurel (*asan*) were sent to London from Orissa and the brokers are very pleased with it.

(10) Four wagon loads of *bija*, rosewood, *bandhan* (*Ougeinia dalbergioides*) and *sal* were placed at Ranchi.

(11) A consignment of seasoned *sal*, and another for 150 B. G. sleepers, was sold to Buxa Jail.

(12) Negotiations for the supply of Ascu treated *sal* poles for electrical transmission are going on.

(13) *Melia composita* was tested and found suitable for pencil making. Orissa will now arrange for supplies to be sent. *Bhurkund* and *Alstonia scholaris* are being tested for pen holders. A large number of species has been found suitable for pen holders manufactured by hand lathe. There should be a scope for such articles as pen holders, rulers, pin cushions, ink stands, blotting pads, police batons and curtain poles if manufactured as a cottage industry.

(14) The Bengal Brush Factory has declared *Holoptelea integrifolia* to be suitable for municipal brushes. They have been put in touch with a contractor. A market for satinwood has been found in Japan and a quotation has been made.

(15) A contractor is endeavouring to manufacture tool handles of *dhaura*. If he succeeds it should be possible for us to obtain substantial orders from the Railways where the supply at present is less than the demand.

(16) An enquiry has been made for seasoned laurel for cabinet making, and stocks of timbers are being laid down. If successful, substantial orders should result.

1. *Wood technology*.—Nil.

2. *Timber seasoning*.—A general complaint amongst consumers is the scarcity of seasoned timber. On the other hand contractors endeavour to unload their stocks as quickly as possible, to minimise the risk from degrade which takes place when logs and sawn material are left lying about, unprotected from too rapid drying in the hot weather. It is hoped to overcome the difficulty by erecting seasoning sheds and to persuade purchasers to place their orders well ahead so that the timber can be delivered in seasoned condition. Our aim is to improve the quality of Bihar timber by persuading contractors to adopt proper seasoning methods. One seasoning shed has already been erected at Gailkera and a sample lot of *asan* has been successfully seasoned and other sheds will follow, as the demand arises. The Forest Research Institute announce that a portable electric machine is available for testing if timber is seasoned. This should be a great help.

3. *Timber testing*.—Nil.

4. (1) *Wood preservation—Ascu preservative*.—The Electrical Inspectors of Bihar and Orissa and Bengal have been persuaded to permit lessees of electrical schemes to use Ascu pressure treated poles instead of steel poles for transmission lines. Recently, as one result of the exhibition in Patna, the Engineer of Postal Telegraphs has also requested us to submit tenders for treated poles.

(2) Our "Ascu" section of the Forest stall at the Patna exhibition attracted much attention. Local mistries could scarcely believe that treated bamboos could last for three years in the ground without decay.

5. *Minor Forest Products—Match woods*.—500 cubic feet of soft hard wood species were sold to the Talcher Match Factory at 6 pies per cubic foot. The rate is rather low but there is no other market for these species.

6. *Paper pulp*.—Nil.

7. *Tans*.—Nil.

8. *Wood Working*.—Nil.

9. *Miscellaneous*.

(1) *Floating, Sambalpur West*.—Two successful experiments were made in which 47,720 bamboos and 23 *bija* logs were floated from

Ramadega inaccessible forest to Sambalpur, a distance of 31 miles. After all expenses were paid a profit of Rs. 1-8 and Rs. 1-9 respectively for each experiment per 100 bamboos was realised. The results are extremely gratifying.

(2) *Porahat division*.—3,000 bamboos were floated down the Karo river as an experiment. After paying expenses the profit was Rs. 1-1 per 100 bamboos.

## BURMA.

### UTILIZATION.

#### I.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Economist was held throughout the year by Mr. M. N. Gallant.

#### II.—EXPERIMENTAL ACTIVITIES.

(i) *Summary of the chief activities during the year under report.*

2. The chief activities of the year are summarised below, the details being given later in the sub-sections concerned.

- (a) Arranging for the supply and passing of 15,710 special-size *pyinkado* (*Xylia dolabriformis*) sleepers to the North Western Railway, Karachi.
- (b) Calculating flat-rate royalty for all lessees and for the Myitmaka Extraction division.
- (c) Examining a quantity of poor quality one star teak logs at the Depot with a view to fixing a standard for jungle rejects through the assessment of wastage due to various defects.
- (d) Observing the cutting of teak logs in Rangoon mills to estimate the conversion loss due to defects.
- (e) Conducting experiments in conjunction with Princes Risborough on the variation of moisture content of teak strips during transit to England.
- (f) Conducting experiments on end-coating teak logs at Kyetpyugan Depot, Insein division, with various end-coating mixtures.
- (g) Organising experiments on the seasoning and working of teak and *in-kanyin* (*Dipterocarpus* spp.).
- (h) Working up data in connection with a proposal to fix royalties on teak by means of an Index figure.
- (i) Working up data on beeholed squares.
- (j) Studying the variation in the quality of teak timber.

(k) Preparation of notes and articles on Burmese timbers, the matchwood industry, the variation in market price of hardwoods throughout the province, etc.

(l) Answering miscellaneous questions on Burmese timbers, lac, catch, paper-pulp, bamboos, *tung* (*Aleurites* spp.), oil and other minor forest produce.

3. During the year under report about three months were spent on tour in connection with sleeper passing, collection of strength test logs, collection of information with regard to shipping sizes and prices of teak, *pyinkado* and *in-kanyin*, etc.

4. The Revised Edition of Rodger's Handbook of Forest Products of Burma which was sent to the press last year was published and distributed.

### (ii) Details of Activities.

#### 1. Wood Technology.

5. Owing to the post of the Forest Botanist being held in abeyance there were no additions during the year to the collection of timber specimens authenticated by botanical specimens from the same trees.

This collection was commenced in 1924 and specimens of a number of the less durable species have deteriorated to such an extent as to be valueless for identification purposes. Steps are being taken to replace these.

6. Hand samples, 6"×3"×½" of the more important economic timbers were supplied to many enquirers in Burma, India, the United Kingdom and elsewhere.

7. Routine identifications of timbers were carried out for numerous inquirers. Those which were included in the Key for Identification of Burma Timbers by Mr. C. W. Scott were identified by hand lens examination in Rangoon. Others by microscopic examination at Dehra Dun to whom acknowledgments are due for help given.

8. Timber for which identification was called for include the following :—

- (1) Bark of *Rhizophora* spp.
- (2) *Rhizophora* (*byu-chi-dauk*).
- (3) *Hopea odorata* (*thingan*).
- (4) *Careya arborea* (*bambwe*).
- (5) *Parashorea stellata* (*thingadu*).
- (6) *Litsaea grandis* (*gaswe-ywet-gyi*).

- (7) Sample sent as *thitka* (*Pentace burmanica* identified as *letkok* (*Sterculia alata*).
- (8) Sample sent as *yon* (*Anogeissus acuminata*) identified as *taukkyan* (*Terminalia tomentosa*).
- (9) Sample sent as *pyinkado* (*Xylia dolabriformis*) identified as *thitka* (*Pentace burmanica*).

9. During the year under report 12 pieces of *thitmin* (*Podocarpus wallichianus*) were sent to Dehra Dun to find out whether the brittleness test shows a value up to the minimum of 6 ft. lbs. as required for aircraft construction. The timber was thoroughly kiln seasoned immediately after conversion to provide fungus free-material. The brittleness test gave poor results being only 4.1 ft. lbs. The timber was also considered heavier than spruce which is the standard timber used in aircraft manufacture. In other respects *thitmin* proved superior to spruce.

10. Two hillets each of artificially grown and naturally grown *pyinkado* (*Xylia dolabriformis*) from Bhamo were sent to Dehra Dun for strength tests. The object of the test being to find out whether *pyinkado* grown in plantation was weaker than timber from natural forest. The results show that there is no material difference in the strength values of artificially grown and natural *pyinkado*.

## 2. Timber Seasoning.

11. The five internal fan kilns gave satisfactory service throughout the year. The three large kilns were solely confined to the seasoning of *yon* (*Anogeissus acuminata*) timber for the manufacture of handles. The year's work for this kiln shows a considerable increase in the quantity of timber seasoned. Thirty-one runs cubing 11,781.3 cubic feet of timber were put through as against 28 runs cubing 9,416.4 cubic feet in 1934-35.

12. The 75 cubic feet kiln was utilised for experiments as well as for supplying workshop demands. This kiln did 12 runs cubing 870.2 cubic feet as against 10 runs cubing 723.2 cubic feet last year. The species seasoned were *hnaw* (*Adina cordifolia*), *yemane* (*Gmelina arborea*), *thitmin* (*Podocarpus wallichianus*) and teak.

13. The 5 cubic feet model kiln was used for experimental work on *yon* and teak.

14. The actual running expenses exclusive of depreciation were Rs. 17,219-10-6 as against Rs. 15,915-15-9 for 1934-35. The total expenditure of the section, inclusive of depreciation charges, was Rs. 20,815-10-6, of this amount Rs. 15,295-10-6 is directly chargeable to the cost of producing 12,652.0 cubic feet of seasoned timber, at the rate of Re. 1-3-4 per cubic foot as against Re. 1-8-6 last year. This figure of Re. 1-3-4 may be regarded as highly satisfactory in view of the

fact that most of the timber dealt with was  $2\frac{1}{2}$ " in thickness. If the timber in the runs had been confined to 1" boards the cost of seasoning would have been reduced as low as 6 annas per cubic foot.

15. *Teak*.—A run of teak flooring strips cut from logs obtained from the Depot and Agency division was put through the 75 cubic feet kiln. This forms part of the research scheme for the seasoning of teak and definite results will be published next year. As far as this run is concerned the following schedule was used:—

The kiln was first warmed up to a temperature of 130°F. at 85 per cent. humidity, taking at least 6 hours to reach the required temperature. After this temperature had been maintained for 3 hours, the temperature and humidity of the kiln was lowered to the drying conditions given below:—

Stage of drying (Moisture content of timber).						Temperature of Dry Bulb.	Humidity.
Per cent.						Deg. F.	Per cent.
Initial	.	.	.	.	.	120	80
35	.	.	.	.	.	125	75
30	.	.	.	.	.	130	70
25	.	.	.	.	.	135	65
20	.	.	.	.	.	140	60
15	.	.	.	.	.	145	55
10	.	.	.	.	.	150	45

16. A special run of very narrow 1" thick teak strips was put through the 5 cubic feet kiln at the request of a local timber firm, who were experimenting with the manufacture of a teak wood pipe. These small pieces were used as "feathers" for the join in the timber. The initial moisture content of the strips was 47 per cent. and was reduced to 12 per cent. in 13 days.

17. The *knaw* (*Adina cordifolia*), *yemane* (*Gmelina arborea*) and *thitmin* (*Podocarpus wallichianus*) put through the 75 cubic feet kiln responded well to the treatment and the following notes on the different species give some indication of the results obtained.

*Hnaw*.—This species was put through in  $4\frac{3}{4}$ " squares, the size required for bobbin manufacture. On account of the large dimension of the timber a relatively mild schedule had to be maintained throughout the run. The timber was initially at about 58 per cent. moisture content, the maximum shrinkage was 2.4 per cent. tangential and 2.0 per cent. radial.

*Yemane*.—There were two runs of this species and in both cases the timber was of 1½" thickness. The first run with an initial moisture content of 40.2 per cent. was dried down to 12.1 per cent. in 13 days. In both cases shrinkage was very low.

*Thitmin*.—This load consisted of 2¾" planks of very wide widths. To begin with the timber was quite green and a very mild schedule had to be used. The initial moisture content was 63.1 per cent. and drying was carried on down to 12.5 per cent. This run took 45 days and the maximum tangential and radial shrinkages were 3.7 and 2.1 per cent. respectively. In future a more severe schedule will be tried out.

18. This year experimental runs of *yon* (*Anogeissus acuminata*) with frequent steamings were continued in the 5 cubic feet kiln and the results are promising. Three successive runs were made and in each case the timber used was 2½" thick and the same schedule was used throughout. The details are as follows:—

Species and run.	NORMAL RUNNING. NO STEAMING TREATMENT EXCEPT AT THE END OF THE RUN.			FREQUENT STEAMING TREATMENTS DURING RUN.		
	Initial M. C.	No. of days to reach 12 per cent. M. C.	Condition of timber.	Initial M. C.	No. of days to reach 12 per cent M. C.	Condition of timber.
1. <i>Yon</i> ( <i>Anogeissus acuminata</i> )	42.7	36	Good—few cracks.	..	..	..
2. <i>Ditto</i> . . .	..	..	..	50.7	32	Good—few cracks.
3. <i>Ditto</i> . . .	..	..	..	36.6	28	Do.

The average saving in time by steaming is 16 per cent. It is proposed to continue these experiments in 1936-37 and to use longer steaming and higher temperatures.

19. *Air-seasoning*.—The recording of data on several *yon* stacks was continued and 8 further stacks of this species were erected during the year. Of these 6 were later unstacked and then seasoning concluded in the kilns. Partial air-seasoning for a period of about six months can reduce the length of the kiln run by about 10 days. In addition to *yon* two other species *ma-u* (*Anthocephalus cadamba*) and *didu* (*Bombax insigne*) were handled for general air-seasoning.

In connection with the research work on teak, several experimental piles were erected during the latter half of the year and are still under observation.

20. At the request of a local timber firm 5 tons of teak flooring strips were placed under observation for air-seasoning during the year. The

experiment was completed and timber returned to the firm but the results have not yet been analysed.

21. *Ventilation of air-seasoning sheds*.—The results of the second phase of this study have just been concluded, but detailed analysis of the results remains pending owing to pressure of work.

22. *Seasonal variation of moisture content experiments*.—The recording of data was continued and three new species were added to those under observation. These were *hnaw* (*Adina cordifolia*), *kyana* (*Carapa moluccensis*), and *yon* (*Anogeissus acuminata*). The data obtained from the 48 samples representing 8 species cut up in 1934-35 have been analysed. Useful information is now available for the following species :—

*Chay* (*Gluta tavoyana*), *kyana*, *maniwaga* (*Carallia lucida*), *petlezin* (*Vitex peduncularis*), *taukkyan* (*Terminalia tomentosa*), *tamalan* (*Dalbergia oliveri*), *thitni* (*Amoora rohituka*) and *yon*.

23. Owing to the pressure of work and lack of kiln space it was found impossible to test out Dr. S. N. Kapur's method for the kiln seasoning of laurel.

24. During the year an attempt was made with the assistance of one of the timber firms to study the moisture content changes of teak during shipment to England. The results so far obtained are not very definite. The Princes Rishorough Timber Research Institute have, however, made some useful suggestions with regard to future experiments and the work will be continued further.

### 3. Timber Strength Testing.

25. Sample logs of the following species were sent to Dehra Dun during the year for routine tests :—

*Under Project I—Tests on small clear specimens.*

*Letpan* (*Bombax malabaricum*).

*Sawbya* (*Sterculia campanulata*).

*Under Project VIII—Veneer and plywood tests.*

*Thitka* (*Pentace burmanica*).

*Pyinma* (*Lagerstræmia flos-reginæ*).

### 4. Wood Preservation.

26. The experiment which was started during 1934-35 on the efficiency of four preservatives supplied for protecting wood against white-ants and decay had unfortunately to be abandoned as the samples were stolen.

27. A new experiment on the same lines but using larger pieces of timber is already in hand. This time the same test will be carried out in Pyinmana in the dry zone as is being carried out in Rangoon,

28. *Fireproofing tests*.—It has been decided to discontinue these tests as the apparatus at our disposal is too primitive. During the course of such tests as were carried out the fire resistant qualities of teak were much in evidence.

29. Arrangements are being made at Princes Risborough to carry out careful fire resistance tests on teak and other important Burma timbers.

30. *End-coating tests*.—Preliminary tests for determining the relative merits of a number of compounds for end-coating timber during seasoning were started during the year. The following compounds were tested :—

- (1) Xylotex G. 10.
- (2) Seekaywax.
- (3) Aluminium paint.
- (4) Waxy by-products.
- (5) Waxy wood preservative.

From results so far obtained the first three compounds have given the best results. The experiments will be continued. Towards the end of the year a similar experiment was started but this time the compounds were applied to the ends of teak logs lying in the Kyetpyugau Depot, Insein division.

No results have so far been obtained from this experiment.

31. *Preservation against marine borers*.—No further tests were carried out in Rangoon during the year but *kanyin* (*Dipterocarpus* spp.) timber was supplied to the Research Officer, Federated Malay States, for this work. No results have been communicated to us so far.

##### 5. *Minor Forest Produce.*

32. *Lac*.—As in former years samples of lac were sent to the Indian Lac Research Institute for test. These samples were sent twice yearly in June and in December, and each consignment consisted of 2 bags containing 20 seers each of *Ari-kusum* (*gyo*)—*Schleichera trijuga* and *Phunki-kusum* lac. The crop statistician of the Indian Lac Research Institute toured Burma as in previous years for a fortnight, January 1936, to collect information on the Burma lac crop.

33. Samples of *Litsea polymorpha* and *L. salicifolia* berries were sent to a Raugoon firm who were interested in the commercial collection of these for candle manufacture. As a result of this firm's investigation, however, it was found that the berries obtained were unsuitable. An enquiry was also received from Dehra Dun for the supply of 5,000 maunds annually of berries of the *Litsea* species. A survey of the province was made to ascertain the amounts available. It was found, however, that the total quantity available was too small to interest the enquirer.

34. Further supplies of the bark and latex of *Holarrhena antidysenterica* (*lettok-gyi*) were sent to the Professor of Chemistry, Rangoon

University, who is continuing his researches on the alkaloids of *H. anti-dysenterica* and on the resinols of the latex of this plant.

35. In last year's report mention was made of tests which had been carried out at the Imperial Institute, London, on nuts of *Aleurites fordii* grown at Taunggyi, in the Federated Shan States. The result of these tests was that the oil from these nuts was abnormal in that it was more like the oil of *A. montana* than *A. fordii*. At the end of 1934 a further consignment, this time of both fruits and nuts, was sent to the Imperial Institute for tests and the following report has been furnished on the results of the investigation :—

“ Two samples, one of fruits and the other of seeds were received and were examined separately. The samples were of particular interest in relationship to the previous sample from the same trees examined in 1934 since the oil from this earlier crop of fruit showed characteristics more closely resembling those of *A. montana* than of its own species. The characteristics of the oils from the present samples approximated more to those normal to the species, but still tended a little towards the lower values of *A. montana*.

It will be noticed that the oil derived from the fruits is of paler colour and lower acidity than that from the seed, and this affords an interesting demonstration of the effect of retaining the fruit in the whole state on the preservation of the oil.

Fruit of Seed.	Sample 1 (fruit).	Sample 2 (seed).	Previous sample of seed examined in 1934.
Average weight of whole fruit, grams . . . .	28.77	..	..
Average number of nuts per fruit . . . .	4.05	..	..
Average weight of nut, grams . . . .	3.6	3.11	3.33
Fruit consists of—			
Husks, per cent. . . . .	49.2	..	..
Nuts, per cent. . . . .	50.8	..	..
Nut consists of—			
Kernel, per cent. . . . .	57.5	58.9	55.7
Shell, per cent. . . . .	42.5	41.1	44.3
Moisture in kernel, per cent. . . . .	1.23	1.65	5.2
Oil in kernel, per cent. . . . .	57.6	59.0	56.2
Oil in dry kernel, per cent. . . . .	58.2	60.0	59.2
Oil in fruit or seed as received, per cent. . . .	16.8	34.8	31.3

Oil.	Sample 1 (fruit).	Sample 2 (seed).	Previous sample of oil examined in 1934.
Colour, Lovibond cell 10 mm.—			
Red . . . . .	0.01	0.24	1.0
Yellow . . . . .	1.6	1.5	6.8
1 in.—			
Red . . . . .	0.24	0.50	1.4
Yellow . . . . .	5.6	4.7	21.4
Paint Research Station, Scale 1 in. . . . .	3	3	5
Refractive Index N. D. 25° C. . . . .	1.5170	1.5175	1.5143
Density (25° C.) . . . . .	0.9342	0.9341	0.9343
Heat test: Paint Research Station Method—			
Time . . . . .	10½ min.	10½ min.	11½ min.
Extract, per cent. . . . .	19.3	21.0	29.1
Acid value . . . . .	0.81	1.11	2.82
Iodine value (Wija), per cent. . . . .	166.7	163.75	162.4

### Remarks.

The results of the examination show that both the fruits and the seed contained a normal percentage of oil and that the oil corresponded more closely to the usual characters of *A. fordii* oil than the previous sample."

36. During the year an attempt was made to organise supplies of wood for charcoal burning for Messrs. The Rangoon Electric Tramway & Supply Co., Ltd. It was found that the high freight made the cost of the wood prohibitive for charcoal burning in Rangoon. The possibility of manufacturing the charcoal in small portable kilns in the forest is now under consideration. Wood loses about  $\frac{2}{3}$ rd of its weight during carbonisation so that the saving in freight charges would be considerable if the charcoal was made in the forests.

The following results showing the percentage of charcoal obtained from different species of Burma woods is of interest:—

Wood.	Percentage charcoal.	Results in use.
1. <i>Pyinkado</i> ( <i>Xylia dolabriformis</i> ) . . . . .	29.1	A
2. <i>Yon</i> ( <i>Anogeissus acuminata</i> ) . . . . .	24.9	B
3. <i>Teak</i> ( <i>Tectona grandis</i> ) . . . . .	24.4	C
4. <i>Myaukcharaw</i> ( <i>Homalium tomentosum</i> ) . . . . .	21.8	A
5. <i>Pine-kanazo</i> ( <i>Heritiera formos</i> ) . . . . .	20.6	C

A	. . . . .	Good results.
B	. . . . .	Fair "
C	. . . . .	Poor "

37. Small quantities of fresh *kalaw* (*Taraktogenos kurzii*) seeds were sent to Africa, Pondicherry and to the Rangoon Leper Asylum for experimental purposes.

Seeds of *Sapium baccatum* and *Kurrimia pulcherrima* collected from the University Estate were sent to the Forest Botanist, Forest Research Institute, Dehra Dun, at his request.

38. An enquiry was received from a firm in Scotland for samples of *ponnyet* (*Calophyllum inophyllum*) to test the suitability of this timber for the making of golf club beads. The samples were sent but no report has so far been received.

39. Other enquiries were for the following :—

1. Burma silver oak (*Grevillea robusta*).
2. Natural grasses.
3. Leaves of *Ficus elastica*.
4. Myrabolans (*Terminalia chebula*).
5. Tamarinds.
6. Bark of *Broussonetia papyrifera*.
7. *Euphorbia neriifolia*.

#### 6. Paper Pulp.

40. An enquiry was received during the year in regard to the possibility of obtaining sufficient quantities of bamboo for the manufacture of paper pulp from the drainages of the Kaladan and Lemro chaungs. As a result of investigation it was found that the Kaladan drainage was not very suitable on account of the number of *taungyas* but that there were distinct possibilities about the Lemro.

The *kayin* (*Melocana bambusoides*) bamboo sample plots in Arakan were reported on during the year. After six years they are making good progress but it will probably take 10 years for the culms to reach maturity.

#### 7. Tans.

Nothing to record.

#### 8. Wood Working.

41. The necessity for economy was felt throughout the year and the expenditure was cut down to a minimum. The figures given below

show that there was practically no variation from the much curtailed expenditure of 1934-35.

*Timber Research division as a whole.*

Year.	Expenditure.	Receipts.	Difference.
1934-35 . . . . .	96,968	62,147	—34,821
1935-36 . . . . .	90,762	38,997	—51,765
Difference . . . . .	—6,206	—23,150	—16,944

*Workshop unit only.*

1934-35 . . . . .	47,153	62,147	—14,994
1935-36 . . . . .	47,259	38,997	—8,262
Difference . . . . .	+106	—23,150	+6,732

The marked drop in workshop receipts during 1935-36 is very largely due to the Workshop Superintendent having gone on six months leave and few orders were taken on other than for the supply of *yon* bundles.

42. The Government sawmill remained closed throughout the year for reasons of economy but the machinery was kept cleaned and greased. Timber supplies were as last year. The logs bought were converted into fitches at Messrs. Foucar's sawmill and the fitches were cut into boards and scantlings on the Depot framesaw.

43. During the year 401 tons of hardwood logs, 31 tons of *kanyin-byu* (*Dipterocarpus alatus*), 2 tons *taukkyan* (*Terminalia tomentosa*) and 20 tons of teak for strength tests were bought. Last year's balance in logs was 23 tons. All the logs were sawn to fitches by Messrs. Foucar & Co. From the logs 416 tons of hardwood fitches were produced, making the loss on rough conversion 12·8 per cent. The conversion result stands almost the same as last year. The above conversion returns do not include the *pagas* produced. The recovery from the *pagas* was 23 tons for making small handles and the unserviceable timber was used as firewood in the dry kiln. In this way a considerable saving was made in fuel bills.

44. The proportion of timber used on furniture work and on non-furniture work compared with previous years is given below :—

	Tons of converted timber charged on job cards.			Book value of timber. Ra.		
	1933-34	1934-35	1935-36	1933-34	1934-35	1935-36
Furniture . . . .	32	15	10	7,015	3,145	1,919
Non-furniture . . . .	55	204	118	10,013	29,239	15,838
TOTAL .	87	219	128	17,028	32,384	17,757

Non-furniture work includes hammer and other tool handles, floor blocks, panellings, mounting blocks, packing and other timber supplied, etc.

45. Altogether 28 different species were handled in the workshop. They are given below, classified according to their use and are arranged in descending order of merit as regards the amount of work done with them :—

*Major attention—*

*Constructional—*

*Padauk (Pterocarpus macrocarpus).*

*Thingan (Hopea odorata).*

*Industrial—*

*Yon (Anogeissus acuminata).*

*Binga (Mitragyna diversifolia).*

*Ma-u (Anthocephalus cadamba).*

*Panga (Terminalia chebula).*

*Didu (Bombax malabaricum).*

*Thitkado (Cedrela toona).*

*Yemane (Gmelina arborea).*

*Kanyin-byu (Dipterocarpus alatus).*

*Hnaw (Adina cordifolia).*

*Thitmin (Podocarpus wallichianus).*

*Ananma (Fagraea fragrans).*

*Furniture—**Sit (Albizzia procera).**Yinma (Chukrasia tabularis).**Padauk (Pterocarpus macrocarpus).**Taukkyan (Terminalia tomentosa).**Thingadu (Parashorea stellata).**Kyana (Carapa moluccensis).**Aukchinza-ni (Amoora wallichii).**Thinwin (Millettia pendula).**Sandawa (Cordia fragrantissima).**Minor attention—**Kyilan (Shorea assamica).**Kaunghmu (Anisoptera glabra).**Pyinma (Lagerstroemia flos-reginæ).**Chay (Gluta lavoyana).**Thitka (Pentace burmanica).**Maniawga (Carallia lucida).*

46. Work was also done on the following species :—

*Tamalan (Dalbergia oliveri)*, *pyinkado (Xylia dolabriformis)*, *banatha (Strombosia javanica)*, *sagawa (Michella champaca)*, *teak (Tectona grandis)*.

47. The timber to which most attention was given in the workshop was *yon (Anogeissus acuminata)* and timber handles continued to be successfully supplied to the Indian Railways. Many orders had to be refused owing to the lack of seasoned timber. A trial order of 3,000 handles was made for the Southern Railway and has been despatched but up to date no report has been received on these. In last year's report mention was made of the failure of *yon* coupling poles supplied to the Southern Railway. This year a small quantity of *yon* poles under 3' girth have been brought to the Depot and are now undergoing seasoning. It is expected that the increased elasticity and pliability of the young material will enable us to make coupling poles up to the Southern Railway standard.

48. The local demand for seasoned *hnaw (Adina cordifolia)* and *binga (Mitragyna diversifolia)* for printing blocks has continued to increase. Moreover enquiries have also been received from India for a supply of these timbers. Until we have been able to build up a small reserve, however, we shall not be able to do more than supply the local market.

49. *Mau* and *taungthayet* (*Anthocephalus cadamba*) and (*Swintonia floribunda*) continued to be used for packing cases. A number of enquiries were received for large supplies of *mau* boxes to replace the boxes from Japan which are being used at present. These had to be refused, however, as no money was available to purchase timber. *Panga* (*Terminalia chebula*) for sucker rod protectors and *thitmin* (*Podocarpus wallichianus*) for ladders, masts and boat-hooks, were still in demand.

50. Of the ornamental woods *yinma* (*Chuckrasia tabularis*), *taukkyan* (*Terminalia tomentosa*), *sit* (*Albizia procera*), *padauk* (*Pterocarpus macrocarpus*), *thitkado* (*Cedrela toona*), *thinwin* (*Millettia pendula*) and *kyana* (*Curapa moluccensis*) were all used for furniture during the year and little complaint was received concerning their behaviour. Of these woods *yinma* and *taukkyan* were probably the most popular and there is every indication that there is a considerable future for these two timbers. *Thinwin* is also finding its proper niche as a flooring, paneling and besding wood.

51. In order to assess the difference in the amount of shrinkage between "green" teak, i.e., teak which could be purchased in the hazaar and properly seasoned teak, an office table and chair and two sets of swing doors were made of unseasoned teak. When the teak which is at present undergoing seasoning tests is ready similar articles will be made of it and the difference in shrinkage between the green teak and seasoned teak compared.

### 9. Miscellaneous.

#### (1) Efforts to increase the sale of Burma timbers.

52. An attempt has been made during the year to work on the lines of the policy laid down in 1933-34 for the future of the Timber Research division, and in accordance with this policy research work on teak and *in-kanyin* (*Dipterocarpus* spp.) was commenced. During the year 1936-37 work will begin on *taungthayet* (*Swintonia floribunda*) and on *pyinkado*. It may appear from this report that the manufacture of *yon* handles hulked too largely in the work of the Research division. We have, however, almost reached the conclusion of this work and if we were to give up entirely the making of handles at this stage the valuable ground already gained might be lost.

53. A great step forward in the matter of teak propaganda was made during the year under report when the principal teak lessees in conjunction with the Forest Department produced an attractive and well illustrated brochure on Burma teak. This brochure has been distributed by the Timber Research division to important timber users throughout Burma, India, South Africa, Australia, America and Europe.

54. Efforts to place untreated teak poles on the market have so far met with indifferent success. Though the cost of wooden poles is less than that of metal posts, the following facts are to be taken into consideration in determining whether wooden poles can be utilized on a larger scale :—

The life of wooden poles is claimed to be 10 to 30 years, whereas that of metal poles is reckoned at a minimum of 45 years.

The transport question from place of disembarkation to site of work is another factor which has to be taken into account. Each of the component parts of metal poles does not exceed 8' in length which admits of easy and economical transport to the site of the work as compared with large heavy wooden poles of 24' or 28' in length

A report was received on the 12 teak poles sent to the Telegraph Workshop, Calcutta, for tests. These poles averaged 2' 6" mid-girth, 24' in length and  $7\frac{1}{2}$ " top-diameter. They were delivered c.i.f. Calcutta at a cost of Rs. 118-14. The report states that the variation in top-diameter was too great and that the poles cracked badly. Both these defects could be surmounted, the former by more careful selection and trimming, the latter by treating the ends of the poles with an anti-splitting end-paint, such as "Xylotex" or tar or an ordinary lead paint. Enquiries are being made from other bodies such as municipalities and electric light companies on the length of life of teak or other wooden poles with a view to finding a market for wooden poles.

55. Towards the end of 1935-36 the Seaman-Limaye Grading Rules for teak were produced. These rules have been based on the data recorded by three Assistant Conservators of Forests in the mills of the principal teak firms and worked up by Mr. Seaman, Officer-in-charge, Timber Testing Section, Dehra Dun. Copies of the rules have been distributed by the Forest Economist to the teak firms but no report was received on them during the period of this report.

Grading Rules for hardwoods drawn up by the Imperial Institute, London, were also received during the year and if time is available during 1936-37 different Burma hardwoods, both in the Timber Depot and in local mills, will be graded according to these rules.

56. During the year orders for 16,380 special sized *pyinkado* (*Xylia dolabriformis*) sleepers were placed through the Utilization Circle for the North Western Railway, Karachi. One order for 10,710 sleepers was completed during the year, the other will be finished by the 31st July 1936. These orders represent an export from Burma of 1,974 tons of converted timber. As in previous years it was found that the best sleepers came from the Pegu Yoma forests. The Moulmein millers though very keen to supply find it difficult to make this specification

for special-sized sleepers, with the timber at their disposal. In Bassein the milling was so bad that very few sleepers could be accepted.

In the last order for special sized sleepers it has been found increasingly difficult to obtain large sleepers with sound boxed heart and the rejections in these sizes has been very high. This has meant a considerable loss to the contractors. In the future some method of end-coating sleepers with boxed heart will have to be adopted to reduce the amount of splitting on arrival in India.

In March 1936 the Northern Group Sleeper Pool asked the Utilization Circle to arrange for the supply of 23,000 B. G. *pyinkado* sleepers which indicates that Burma *pyinkado* is becoming fairly established as a sleeper wood and greatly increased orders may be expected in the future if the high quality is maintained and the prices kept down.

57. During the year under report efforts were made to find a market for teak sleepers. In the Northern Shan States division there are some teak girdlings which are unextractable by water owing to the nature of the forest. The Divisional Forest Officer is willing to sell these in the form of sleepers sawn by hand. The Burma Railways were approached on the subject and they are willing to buy special size sleepers for use at the Gokteik Viaduct provided the price is reasonable. Specifications for the special size sleepers were obtained and the Divisional Forest Officer is going into further details.

58. The efforts of the Timber Research division to firmly establish the demand for *yon* (*Anogeissus acuminata*) handles have been discussed elsewhere in the report. The numerous orders for handles from India, many of which had to be refused, seem to indicate that the timber is increasing in popularity and that the large scale production of *yon* handles by the Timber Research division has been justified.

The proposals which were put forward at the end of 1933-34 by the East Indian Railway to purchase green *yon* from Burma and to season and fashion it into handles for general supply to the Indian Railways has not yet materialised. It is hoped, however, that during 1936-37 some advance may be made in the matter.

In regard to *yon* the policy of the Timber Research division is to build up a sufficiently large stock of seasoned timber to supply a 2 years demand for handles. This will enable anyone who decides to take up the handle business to begin manufacture immediately without having to lay out a large amount of capital in building kilns or in building up stocks of air-seasoned timber.

59. Owing to the reduced budget of the Timber Research division many promising orders for timber had to be turned down. The fol-

lowing are a few of the more important orders which had to be refused for lack of seasoned stocks :—

*Taukkyan* (*Terminalia tomentosa*) and *padauk* (*Pterocarpus macrocarpus*) for the Timber Adviser to the High Commissioner for India, London.

*Yon* tool handles—Indian Railways.

*Ma-u* (*Anthocephalus cadamba*) for boxes.

*Binga* (*Mitragyna diversifolia*)—25 tons per month for Mills Stores Co.

*Thingan* (*Hopea odorata*) for Standard Oil Co.

*Binga and hnaw* (*Mitragyna diversifolia* and *Adina cordifolia*) for engraving blocks.

Several enquiries from Calcutta.

60. Small supplies of these timbers are to be put down for air-seasoning in 1936-37 and it is hoped that we shall be able to meet the demands for some of these timbers which can be supplied in bulk.

61. Nine figured *tauikkyan* (*Terminalia tomentosa*) logs and six *thin-win* (*Millettia pendula*) logs have been extracted departmentally to the Government Timber Depot. The Timber Adviser to the High Commissioner for India, London, is at present negotiating with brokers in London for the sale of these. If he is successful these logs will be shipped to London in the round.

62. There is a certain demand in Europe now for *in-kanyin* (*Dipterocarpus* spp.) for flooring strips. In order to foster this demand a certain amount of *in-kanyin* in flooring strip sizes has been put down for air-seasoning at the Ahlone Depot. Later on these will be graded according to the Hardwood Grading Rules and offered to the Timber Adviser to the High Commissioner for India, London, for disposal.

63. During the year 2 panels and 1 writing bureau were made in the Depot workshop of *yinma* (*Chukrasia tabularis*) and sent to London for exhibition in India House.

64. The usual display of Burma timbers was made at the Arts, Crafts and Industrial Exhibition held at Rangoon in February 1936, and a descriptive article was supplied for the Exhibition Guide Book.

65. The regulation of the supply of match-woods to factories referred to in last year's report was under examination during the year. A survey of the matchwoods of the Province was undertaken and a report is now being drawn up.

(2) *Comparative counts of beeholes made by the moth Xyleutes (Duomitus) ceramicus in teak from various localities.*

66. No further work was undertaken on the counting of beeholes. The data received from the teak firms in 1934 for beeholed squares was worked up by the Forest Economist during the year. The results obtained followed the general rainfall theory and have been forwarded to Mr. E. G. Lewis at the Rangoon University who will submit these figures to various statistical tests. Even if these tests fail to reveal any information from the present figures they are very likely to indicate some new approach to the subject. Further work on beehole research will not be undertaken by the Forest Economist as results are more readily obtained by the Forest Entomologist by field work.

(3) *Departmental export of Burma timbers.*

67. The shortage of funds still made departmental export of timber difficult and it was necessary to curtail activities in this direction to the shipment of 3,000 *ycu* (*Anogcissus acuminata*) handles to the Southern Railway and to the teak logs supplied to the British Admiralty by the Depot and Agency division.

(4) *Timber passing.*

68. The large orders for special-size *pyinkado* (*Xylia dolabriformis*) sleepers for the North Western Railway, Karachi, necessitated a considerable amount of extra work as practically all the sleepers were offered for passing away from Rangoon. It was found that the sleepers from the Pegu Yomas were very much superior to the others. A complete record of rejections was not kept but such information as is available is summarised below :—

—	Sleepers passed.	Rejections.
Moulmein . . . . .	2,173 1,581	Very heavy (over 50 per cent). 659
Rangoon (timber from Pegu supplied by U Ba & H. Nandlall, Insein).	2,726 652	Few rejections (about 10 per cent). 92
Toungoo . . . . .	471 516	26 Very few rejections (about 4 per cent).
Bassein . . . . .	298	Very heavy rejections (over 50 per cent).
Mihla. . . . .	176	108

On one occasion 700 odd sleepers offered at Bassein were all rejected. Apart from excessive waste and sap, the sleepers had not been cut to size. The miller was inexperienced but even so it is inexcusable that he entirely omitted to allow for kerf in setting his saw. For a 10" cut, say, he set his bench at exactly 10". With a kerf of  $\frac{1}{2}$ " or more, his 10" sleepers turned out at 9 $\frac{1}{2}$ " only.

69. Twenty-five *pyinkado* squares belonging to a local firm were inspected and a passing certificate issued.

#### (5) *Wood fuel for the Burma Railways.*

The scheme whereby the Burma Railways furnish a list of their fuel requirements for the year at various stations and are given a statement of possible sources of supply for reproduction in their annual call for tenders, continues to work well. The Railways experienced a certain amount of difficulty with their fuel supply for the workshops at Myitnge. An enquiry into this was made and proposals for regulating the supply were made and are under consideration.

#### (6) *Enquiries and liaison.*

70. Miscellaneous enquiries were answered on timber, fuel, charcoal, bamboos, lac, cutch, *tung* oil, etc.,. The usual liaison was maintained with other specialists in Burma and at the Forest Research Institute, Dehra Dun; also with the Forest Products Research Laboratory, Princes Risborough, England; Imperial Institute, London; Royal Botanic Gardens, Kew; Timber Advisory Officer with the Railway Board, Delhi and the Timber Adviser to the High Commissioner for India, London. Acknowledgments are due for help from all these sources.

71. Technical Bulletins, Journals and other publications were received from Great Britain, America, Australia, Africa, French-Indo-China and the Philippines and elsewhere.

#### (7) *Ledger Filing.*

72. Ledger filing has suffered severely in the past as one clerk was unable to deal with the additional work and typing involved. When a second clerk was attached to the Forest Economist's staff on the 3rd December 1935 more time could be spent on the maintenance of the ledger files. All matter of interest in the literature received which appears to be of importance to Burma is put in these files.

## CENTRAL PROVINCES.

## UTILISATION.

## I.—GENERAL WORK OF ADMINISTRATION.

The office of utilization officer was held as follows during the year :—

1st April to 4th May.—Mr. Indrajit Sharma, Extra Assistant Conservator of Forests.

5th May to 31st March.—Mr. Abdus Salam, Extra Assistant Conservator of Forests.

## II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

As in previous years, the utilization officer conducted the auction sales of departmentally extracted timber at the depots at Khirkian Timarni, Taku, Ellichpur, Khatkali and Ballarshah. These sales realised Rs. 8,26,604 compared with Rs. 7,24,685 in the previous year. The prices realised per cubic foot were generally slightly lower than in the previous year, due to the continued depression, particularly in Berar, but there was a satisfactory increase in the quantity of timber sold at almost every depot. Timber from coupes in the North Tapti range in the Betul division was for the first time extracted departmentally to a depot at Betul, but the results were financially disappointing, although the timber is reported to have created a favourable impression in the Nagpur markets, to which some of it was sent.

*Sal Sleepers.*

*Sal Sleepers.*—The total value of sleepers supplied to the railways amounted to Rs. 1,55,301, a slight fall on the previous year, due to smaller quota being allotted to the provinces. A three-year contract was secured during the year, under which 20,000 broad gauge sleepers, 25,000 metre gauge, and 30,000 narrow gauge will be supplied annually.

*Lac.*—The total quantity of lac collected in all divisions amounted to 2,146 maunds against 1,307 maunds in the previous year; the largest quantities were collected in the Damoh, Saugor, Seoni and Raipur divisions. Climatic conditions were again generally unfavourable, the increase in yield being due to the infection of a larger number of trees. The T. N. rate again fell from Rs. 35 to Rs. 22 per maund.

*Kulu gum (Sterculia urens).*—The departmental collection of *kulu* gum was undertaken in the Saugor and Damoh divisions, and its extension to other divisions is contemplated. Sales of the gum realised Rs. 14,742, or Rs. 10,000 more than in the previous year.

*Myrabolans.*—The market prices of myrabolans continued as low as in the previous year, and the total revenue from this source amounted to only Rs. 5,760 from the whole of the Government forests of the province.

*Bamboos*.—Departmental collection of bamboos was again undertaken in the Bilaspur division; the sales amounted to only Rs. 11,277, or little more than half those of 1934-35, in consequence of severe competition.

*Miscellaneous Commercial activities*.—The Timher Transport Company carried 258,145 cubic feet of timher from Allapilli to Ballarshah, a distance of 62 miles: the amount carried is somewhat less than in the previous year. The Allapilli Saw-Mill continued to work satisfactorily and gave an outturn of 211,726 cubic feet.

In the Melghat, Hoshangahad and Nimar divisions the hand-sawing of hutt ends and top pieces of teak logs was developed and resulted in more thorough working of the departmentally exploited coupes: 18,822 cubic feet of timher was thus converted, an increase of 5,000 cubic feet. In the sal forests of the Eastern Circle the sawing of sal scantlings is being undertaken to an increasing extent and if sufficient markets can be found, the yield from this source is eventually likely to be very great.

#### *Trial indents.*

*Xylia xylocarpa*.—The small order placed last year by the Nizam's State Railway was met and an order for two more wagon loads is being supplied from Chanda and Bhandara.

*Hardwickia binata*.—Samples have been supplied to a firm from the Nimar division and it is hoped that this may lead to an expansion of the sales of this timher.

*Acacia catechu*.—As an experiment 300 poles were collected from the Allapilli forests and were sold without difficulty at Ballarshah.

*Chloroxylon swietenia*.—About 156 cubic feet of poles were collected and sold by auction at Ballarshah; very satisfactory prices were realised.

*Adina cordifolia*.—2,515 cubic feet were supplied on order from the Ballarshah depot.

*Terminalia tomentosa*.—An increased quantity of pole and round logs was collected at Khirkia and sold by auction. The poles were readily saleable. 13,617 cubic feet of large logs, or 4,000 cubic feet more than in 1934-35, were supplied on indents from the South Chanda division. An order for four wagon loads was secured from the Gun Carriage Factory, Juhulpore, and was met from Chhindwara.

*Ougeinia dalbergioides*.—2,888 cubic feet were sold at the Taku depot and realised a fair price.

*Pterocarpus marsupium*.—No orders were secured from the railways timber up to their specifications is not available.

*Borvelia serrata*.—There is a developing market in Nagpur for this species for use in the manufacture of packing cases.

## MADRAS.

## UTILISATION.

## 1.—GENERAL WORK OF ADMINISTRATION.

The Forest Utilization Officer continued to organize special sales of logs, the supply of sleepers and the development of minor forest produce. Since February 1936 auction sales in the timber depots have been conducted by the respective District Forest Officers in order to enable the Forest Utilization Officer to devote more of his time to the other important activities of his work, such as the study of market conditions, extension of uses of wood, both by proper seasoning and the use of wood preservatives, development of lac, the possibilities of the paper industry in Madras, and propaganda, especially in organising exhibitions, etc.

## 2.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

i. *Timber Tests*.—Nil.

ii. *Experimental sleepers—Inspection of*.—These were inspected as usual. The following points of interest were noted.

*Pecilonuron indicum*.—The average life of untreated B. G. sleepers of this species was found to be about five years, while degrade on treated sleepers which were on the track since 1932 was found to be very little.

*Eugenia gardneri*.—The average life of untreated M. G. sleepers in sand hallast was found to be under five years.

It was also noticed during the inspection that *karimarudu* (*Terminalia tomentosa*) sleepers laid on the line as far back as 1911 and 1917 were still found on the track near Mangalore on the West Coast. This is a testimony to the life of really sound and well seasoned *karimarudu* sleepers on the track.

iii. *Pencil woods*.—A sample of *Melia composita* wood was tried in the Madras Pencil Factory, Madras. The Company reported that the wood was not suitable for their purpose since it was found that the timber was porous.

iv. *Match woods*.—A sample of safety matches prepared from *Melia dubia* splints in the match factory, Palghat, was found to burn steadily and slowly and the splints did not break off on striking. It might be classed as fair for splints. The timber has been declared not fit for veneers for match boxes.

v. *Turnery work*.—A sample of *Wrightia tinctoria* was sent to the Director of Industries for the manufacture of turned wooden articles

for export, such as egg cups, powder boxes, etc. The finished articles in *Wrightia tinctoria* turned out very well.

vi. *Cigar boxes*.—Supplies of red cedar scantlings to Messrs. Spencer & Co., Dindigul, were arranged from the Kal Ar Valley, Coimbatore South division, to meet their requirements for a full year.

vii. *Slate frames*.—Attempts made to interest private firms to utilize softwoods from Kurnool division for slate frame manufacture were not successful owing to the import of cheap ready made frames from Malabar.

viii. *Aircraft*.—The suitability of *Polyalthia fragrans* of certain maximum girth available in the South Coimbatore division for the above work is being investigated and the matter has been taken up by the Forest Economist, Dehra Dun, with the Director of Civil Aviation.

ix. *Palm jaggery manufacture*.—Attempts made to interest certain firms in the lease of *Palmyra* palm trees from Cuddapah North division for tapping sweet toddy for the manufacture of jaggery were unsuccessful.

### *Commercial activities.*

i. *Track sleepers*.—30,270 broad gauge and 18,963 metre gauge hardwood sleepers were supplied to the South Indian Railway during 1935-36 at Rs. 6 per B. G. and Rs. 2-12-0 per M. G.

ii. *Special sized teak sleepers*.—A supply of 15,970 teak special sized sleepers was made to the South Indian Railway valued at Rs. 1,69,920.

iii. *Special orders and overseas trade*.—Except for the supply of 608 c. ft. of *venteak* (*Lagerstræmia lanceolata*) logs at Rs. 1-6-0 per c. ft. f.o.r. Pollachi to the South Indian Railway from Pollachi depot, no further supplies were made to the railways. About 7,850 c. ft. of teak and 1,507 c. ft. of *karimarudu* (*Terminalia tomentosa*) were supplied to the Public Works Department and Jails valued at Rs. 18,845-5-0.

There were no overseas sales.

iv. *Timber market*.—Showed slight signs of improvement as was evidenced from the attendance in auctions though prices have not risen appreciably.

The rate for good quality teak and rosewood logs ranged from Rs. 1-8-0 to Rs. 2-14-0 per c. ft. and there was a demand for export quality rosewood logs, the price offered being Rs. 4-0-0 per c. ft. The rates for other miscellaneous species ranged from Re. 0-12-0 to Re. 1-8-0 per c. ft.

### *Minor Forest Products.*

*Nux vomica*.—The demand for *Nux vomica* was mainly for export purposes. About 270 candies of Sriharikota *Nux vomica* in Nellore

division collected departmentally during 1935-36 was sold at Rs. 12-8-0 per candy (500 lbs.).

*Tans.*—The demand for indigenous tan barks of *Cassia auriculata* and *Cassia fistula* was below normal, owing to the import of South African wattle bark at cheap rates.

The results of examination by the Leather Research Chemist of *Cassia auriculata* bark from experimental plantations in Vizagapatam and Anantapur divisions are given below :—

*Vizagapatam division.*—Barks from one year old coppice shoots (Analysis calculated to 10 per cent. moisture).

	Per cent. Tans.	Per cent. Non-tans.	Per cent. Non-solubles.
Plot I Tangedu bark . . .	17.71	10.15	62.14
" II " . . .	17.26	9.42	63.32
" III " . . .	17.80	9.42	62.78
" IV " . . .	17.25	11.96	60.79
" V " . . .	18.24	11.17	60.59

*Anantapur division.*—Barks from coppice shoots 3 years old in plots I-IV and one year old in plot V calculated to 10 per cent. moisture.

	Tans. Per cent.	Non-tans. Per cent.	Insolubles Per cent.
1. Avaram barks from shoots thicker than a pencil Plot I (3 years) . . .	18.39	11.75	59.86
2. Avaram barks thinner than a pencil . . .	18.13	11.69	60.18
3. Avaram barks thicker than a pencil Plot II (3 years) . . .	18.40	11.93	59.67
4. Avaram barks thinner than a pencil Plot II (3 years) . . .	17.08	11.91	61.01
5. Avaram barks from shoots thicker than a pencil Plot III (3 years) . . .	18.88	12.26	58.86
6. Avaram barks thinner than a pencil Plot III (3 years) . . .	17.70	11.72	60.58
7. Avaram barks thicker than a pencil Plot IV (3 years) . . .	19.04	10.87	60.09
8. Avaram barks thinner than a pencil Plot IV (3 years) . . .	18.41	12.21	59.38
9. Barks from one year old coppice shoots thicker and thinner than a pencil. Plot V . . .	18.18	9.24	62.58

*Lac.*—Lac cultivation was expanded on a larger scale in the Cumbum valley, Madura district, on the lines of the Lac Working scheme. During

the year about 25,835 lbs. of lac (stick, scraped and seed lac) produced in Madura District were disposed of locally in the Presidency and the revenue realised was about Rs. 6,692 as against Rs. 4,772-9-3 realised during the previous year.

The supply of seed lac to the Superintendent of Prisons, Madras, was made at the agreed rate of Rs. 21-9-0 per maund f.o.r. Madras as against Rs. 25 in the previous years, and other sales were made at Rs. 30 per maund *ex-depot* Cumbum. Scraped lac from May 1935 crops fetched a price of Rs. 18 per maund *ex-depot* Cumbum, while the November crop was sold at Rs. 16-8-0 per maund on account of the fall in price in the Calcutta market.

Lac operations were also carried out in Salem North division and the lac produced there is mainly converted into shellac and wood polish and supplied to the Jails and Industrial schools, etc. The Superintendent of Prisons, Madras, purchased about 150 lbs. of shellac at annas eight per pound f.o.r. Madras. Wood polish supplied to various Jails during the year was 128 gallons valued at Rs. 521-7-0. During the year our wood polish was fairly well established among customers, and on account of its superior quality Messrs. Spencer & Co., Madras, purchased during the year 105 gallons of I grade polish valued at Rs. 435-12-0 and they have become regular buyers.

Lac operations in the Nilgiris, Coimbatore North and Godavari Upper divisions have been started.

*Kivan fibre*.—The right to remove *kivan* fibre (*Helecteres isora*) from the forests in the Tinnevely division was leased. It is reported that *kivan* fibre is the best of its kind for the manufacture of gunny bags, being superior even to jute and sisal bemp.

*Sandal bark—Its tannin contents*.—At a previous analysis of sandal bark in 1927 the presence of 20.6 per cent. of tannin in it was noticed. Its effect in tanning of skins or hides had not then been investigated. During the year under review, the Leather Research Chemist, Madras, was requested to investigate this matter and for this purpose some sandal bark was supplied from Salem North. The examination made by the Leather Research Chemist gave the following analytical result.

	Per cent. calculated to 10 per cent. moisture.
Tans . . . . .	21.69
Non-tans. . . . .	4.71
Insolubles . . . . .	63.60
Moisture . . . . .	10.00
Colour $\frac{1}{2}$ per cent. solution in $\frac{1}{2}$ c.m. cell—	
Y . . . . .	12.7
R . . . . .	18.1

The Leather Research Chemist is of opinion that the quantity of sandal hark annually available being limited, there seems little use in attempting to introduce it in the South Indian tanneries. The results obtained so far are only of scientific interest and not of practical use to trade.

*Charcoal kiln.*—An experimental portable “Frikiln” as designed by the Forest Research Institute was manufactured by the P. W. Workshops at a cost of Rs. 486-2-0 and experiments are being conducted by the Working Plans Officer, Madanapalle.

## PUNJAB.

### UTILIZATION.

Experiments with tarring of sleeper-ends was continued from the last year in the Seraj division.

In experiments in Upper Bashahr division for determining the effect of sawing and launching in different months on the conditions of sleepers as delivered in the sale depot, the best results as given by the percentage (35.14 per cent.) of passing by the railway were obtained with sleepers sawn during April to July and launched in August. With sleepers sawn during September—October—July followed by launching during July—August—September, the passing was 19.33 and 17 per cent. of the number of sleepers offered.

## UNITED PROVINCES.

### UTILIZATION.

The Forest Research Institute at Dehra Dun has shown that the strength of the local *Fraxinus micrantha* is superior to English ash and American white ash. Unfortunately it is very uncommon.

Data are being collected on tapping *Sterculia urens* for gum.

The large resin experiment continues. The third year seems to confirm that deep tapping gives the greatest flow but causes more, though not serious, mortality. Twisted trees have yielded more than straight trees. Results will eventually be published.



## APPENDIX I.

*List of Provincial Forest Publications of 1935-36 (excluding the Forest Research Institute Publications).*

## ASSAM.

Provisional Volume Tables and rates of growth for a few important species in the mixed forests of Upper Assam, by C. Purkayastba.

*Indian Forester—*

The Conifers of the Balipara frontier tract, Assam, by N. L. Bor.

Goalpara Forest division, Assam, by R. N. De.

*Vitex peduncularis* and blackwater fever, by L. J. de La Nougerede.

Trans-frontier Tour in the Naga Hills, by N. L. Bor.

## BENGAL.

Forests of Bengal, 1935.

*Indian Forester—*

Skidding pan made from buttress of a tree, by R. I. Macalpine.

*Hoplocerambyx spinicornis* in the sal forests of Terai, Kurseong division, by Y. S. Abmad.

A note on *Cryptomeria japonica*, by C. K. Homfray.

Teak seedlings *versus* root and shoot cuttings, by R. I. Macalpine.

Bamonpokri teak plantation, by Y. S. Abmad.

## BIHAR AND ORISSA.

*Indian Forester—*

Effect of burning on the rate of growth of medium quality sal coppice, by F. C. Osmaston.

Expedition into Sikkim, by F. C. Osmaston.

Seedlings *versus* root and shoot cuttings, by W. D. M. Warren.

Possibilities from irrigation of dry type hill forests, by W. D. M. Warren.

## BOMBAY.

*Indian Forester—*

Close range lightning, by J. Abraham.

## BURMA.

Handbook of the Forest Products of Burma (Revised edition), 1935.

*Indian Forester—*

On *Melocanna humilis*, Kurz, by C. E. Parkinson.

On some Indian and Burmese Dillénias, by C. E. Parkinson.

Treatment of teak seed before sowing in Taungyas, by R. W. V. Palmer.

The influence of the growing use of substitutes for timber upon forest policy, with special reference to Burma, by S. F. Hopwood.

Some notes on the percentage loss in timber volume of teak due to bad form and breakage in felling, and natural defects, by R. Hobbins.

## CENTRAL PROVINCES.

*Indian Forester—*

A scheme for determining the ideal sequence of felling in pasture forests, by K. P. Sagreiya.

Bridge built by Balaghat Forest School students, by A. C. Hopkins.

## MADRAS.

*Indian Forester*—

Concerning rain gauges, by W. C. Hart.

Aerial reconnaissance in the forests of Madras, by C. C. Wilson.

Down in the forest something stirred, by Alyson Minchin.

A little red seed, by Alyson Minchin.

Seed origin and its importance in Indian Forestry, by M. V. Laurie.

*Pinus caribaea*, by M. V. Laurie.

## PUNJAB.

Aerial Ropeways, Punjab Forest Leaflet No. 15, 1935.

*Indian Forester*—

Holy Groves, by R. M. Gorrie.

Gradations in Thinning Intensity, by R. M. Gorrie.

The mesquite in the Punjab, by R. N. Parker.

Concrete flume damaged by roots, by N. G. Pring.

Memorandum on Changa Manga sissoo, by Allah Bakhsh.

Rate of spread of lantana in Chamba, by R. N. Parker.

Form factors for kosh (alder) firewood, by Naranjan Singh.

Ditto ditto by I. D. Mahendra.

The marketing of timber at Doraba, by Khem Chand.

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Our Forests, by F. C. Ford-Robertson, 1936.

Taungya (or *Bankheti*) Cultivation, 1935.

List of Forest Tree Species of Dehra Dun division in the order of their Frost Hardiness, by J. E. C. Turner, U. P. Forest Leaflet No. 3, 1935.

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Seed collection and its importance to Indian Forestry, by K. D. Joshi.

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*Statement showing rank, designation and address of Forest Officers employed exclusively on research work in the various Provinces during the year 1935-36.*

Serial No.	Name.	Designation.	Address.
1	Mr. C. Purkayastha, Deputy Conservator of Forests.	Held the combined post of Botanical Officer and Silviculturist.	Shillong.
2	Mr. S. M. Deb, Extra Assistant Conservator of Forests.	Forest Utilization Officer, Assam.	Gauhati.
3	Mr. C. K. Homfray, Deputy Conservator of Forests.	Silviculturist, Bengal (for part of the year).	Darjeeling.
4	Mr. R. I. Macalpine, Deputy Conservator of Forests.	Silviculturist, Bengal (for rest of the year).	Do.
5	Mr. T. M. Coffey, Deputy Conservator of Forests.	Forest Utilization Officer, Bengal (for part of the year).	Do.
6	Mr. C. T. Trigg, Deputy Conservator of Forests.	Forest Utilization Officer, Bengal (for rest of the year).	Do.
7	Mr. F. C. Osmaston, Deputy Conservator of Forests.	Forest Research Officer, Bihar and Orissa (for part of the year).	Ranchi.
8	Mr. W. D. M. Warren, Deputy Conservator of Forests.	Forest Research Officer, Bihar and Orissa (for rest of the year).	Do.
9	Mr. M. N. Gallant, Deputy Conservator of Forests.	Forest Economist, Burma	Rangoon.
10	Mr. R. W. V. Palmer, Deputy Conservator of Forests.	Silviculturist, Burma (for part of the year).	Maymyo.
11	Mr. C. W. D. Kermode, Deputy Conservator of Forests.	Silviculturist, Burma (for rest of the year).	Do.
12	Mr. P. F. Garthwaite, Assistant Conservator of Forests.	Forest Entomologist, Burma (from 1st April 1935 to 23rd March 1936).	Do.
13	Mr. L. J. Vernal, Assistant Conservator of Forests.	Forest Entomologist, Burma (from 24th March 1936 to 31st March 1936).	Do.
14	Mr. H. C. B. Jollye, Deputy Conservator of Forests.	Silviculturist, Central Provinces.	Nagpur.
15	Mr. Indrajit Singh, Extra Assistant Conservator of Forests.	Utilization Officer, Central Provinces (from 1st April 1935 to 4th May 1935).	Do.

Serial No.	Name.	Designation.	Address.
16	Mr. Abdus Salam, Extra Assistant Conservator of Forests.	Utilization Officer, Central Provinces (from 5th May 1935 to 31st March 1936).	Nagpur.
17	Mr. A. L. Griffith, Deputy Conservator of Forests.	Silviculturist, Madras . . .	Ootacamund.
18	Mr. I. D. Mahendru, Extra Assistant Conservator of Forests.	Divisional Forest Officer, Silvicultural division, Punjab (from 1st April 1935 to 9th March 1936).	Lahore.
19	Dr. R. M. Gorrie, Deputy Conservator of Forests.	Divisional Forest Officer, Silvicultural division, Punjab (from 10th March 1936 to 31st March 1936).	Do.
20	Mr. Ram Saran Chopra, Extra Assistant Conservator of Forests.	Attached to the Silvicultural division, Punjab.	Do.
21	Mr. E. C. Mobbs, Deputy Conservator of Forests.	Silviculturist, United Provinces (for part of the year).	Nainital.
22	Mr. F. C. Ford Robertson, Deputy Conservator of Forests.	Silviculturist, United Provinces (for rest of the year).	Do.
23	Mr. Sohan Singh Negi, Extra Assistant Conservator of Forests.	Assistant Silviculturist, United Provinces.	Do.
24	Mr. Chandra Mohan Johri, Extra Assistant Conservator of Forests.	Assistant Silviculturist, United Provinces.	Do.

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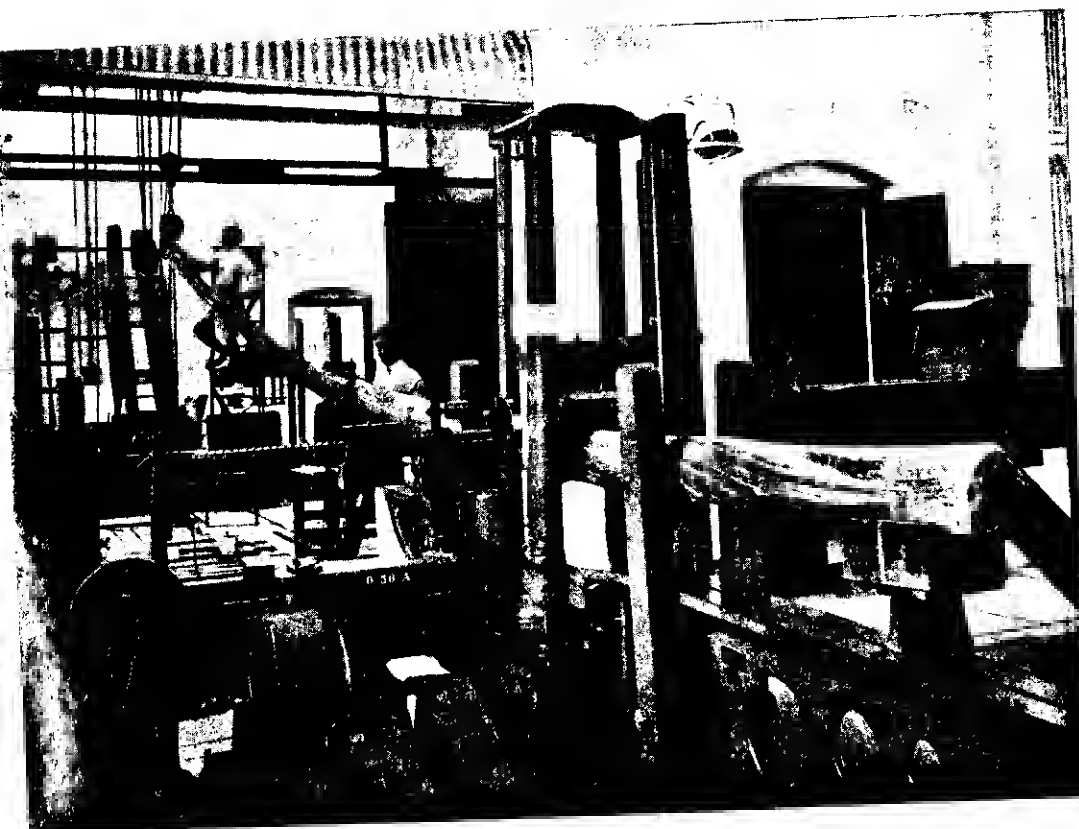
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 Chatterjee & Co., 3, Bacharam Chatterjee Lane, Calcutta.  
 Chukerverty, Chatterjee & Co., Ltd., 13, College Square, Calcutta.  
 City Book Club, 98, Phayre Street, Rangoon.  
 Das Gupta & Co., 54/3, College Street, Calcutta.  
 Delhi and U. P. Flying Club, Ltd., Delhi.\*  
 English Book Depot, Ferozepore.  
 English Book Depot, Taj Road, Agra.  
 English Bookstall, Karachi.  
 English Bookstores, Abbottabad, N.-W. F.P.  
 Fakir Chand Marwah, Peshawar Cantonment.  
 Fono Book Agency, Simla.  
 Gautama Brothers & Co., Ltd., Weston Road, Cawnpore.  
 Higginbothams, Madras.  
 Hindu Library, 137/F, Balamaram De Street, Calcutta.  
 Hyderabad Book Depot, Chaderghat, Hyderabad (Deccan).  
 Imperial Book Depot and Press, near Jama Masjid (Machhliswalan), Delhi.  
 Indian Army Book Depot, Dayalbagh, Agra.  
 Indian Book Shop, Benares City.  
 Indian School Supply Depot, Central Avenue, South P. O. Dharamtala, Calcutta.  
 Insurance Publicity Co., Ltd., Lahore.  
 International Book Service, Poona 4.  
 Jacques & Co., Kamptee Road, Nagpur, Messrs. Neston.  
 Jaina & Bros., Mori Gate, Delhi and Connaught Place, New Delhi, Messrs. J. M.  
 Kamala Book Depot, 15, College Square, Calcutta.  
 Karnataka Publishing House, Bangalore City.  
 Keale & Co., Karachi.  
 Khabao Bookstall, Khadiabazar, Belgam.  
 Kitabistan, 17-A, City Road, Allahabad.  
 Krishnaswami & Co., Teppakulam P. O., Trichinopoly Fort, Messrs. S.  
 Lahiri & Co., Calcutta, Messrs. S. K.  
 Local Self-Govt. Institute, Bombay.  
 London Book Co. (India), Arabah Road, Peshawar, Murree, Nowshera and Rawalpindi.  
 London Book House, 17, Rajpur Road, Dehra Dun, Messrs. The.

Malhotra & Co., Post Box No. 94, Lahore, Messrs. U. P.  
 Malik & Sons, Sialkot City.  
 Mathur, B.S., Book-seller, Civil Lines, Jodhpur.  
 Minerva Book Shop, Anarkali Street, Lahore.  
 Modern Book Depot, Basar Road, Sialkot Cantonment and Napier Road, Jullundur Cantonment.  
 Mohanlal Dossabhai Shah, Rajkot.  
 Nandkishore & Bros., Chowk, Benares City.  
 New Book Co., "Kitab Mahal", 192, Hornby Road, Bombay.  
 Newman & Co., Ltd., Calcutta, Messrs. W.  
 Oxford Book and Stationery Company, Delhi, Lahore, Simla, Meerut and Calcutta.  
 Parikh & Co., Baroda, Messrs. B.  
 Pioneer Book Supply Co., 20, Shib Narayan Das Lane, Calcutta, and 219, Cloth Market, Delhi.  
 Popular Book Depot, Grant Road, Bombay.  
 Punjab Religious Book Society, Lahore.  
 Raghunath Prasad & Sons, Patna City.  
 Ram Krishna Bros., Opposite Bishrambag, Poona City.  
 Ram Narain Lal, Katra, Allahabad.  
 Rama Krishna & Sons, Book-sellers, Anarkali, Lahore.  
 Ramesh Book Depot & Stationery Mart, Kaashmere Gate, Delhi.  
 Ray & Sons, 43, K. & L. Edwardes Road, Rawalpindi, Murree and Peshawar, Messrs. J.  
 Roy Chowdhury & Co., 72, Harrison Road, Calcutta, Messrs. N. M.  
 Saraswati Book Depot, 25, Lady Hardinge Road, New Delhi.  
 Sarkar & Sons, 15, College Square, Calcutta, Messrs. M. C.  
 Sarkar & Co., Ltd., 4, Hastings Street, Calcutta, Messrs. P. C.  
 Sharada Mandir Ltd., Naj Sarak, Delhi.  
 Standard Book Depot, Lahore, Dalhousie and Delhi.  
 Standard Bookstall, Karachi.  
 Standard Bookstall, Quetta.  
 Standard Law Book Society, 60, Harrison Road, Calcutta.  
 Tara & Sons, Razmak (India), Messrs. B. S.  
 Taraporevala Sons & Co., Bombay, Messrs. D. B.  
 Thacker & Co., Ltd., Bombay.  
 Thacker, Spink & Co., Ltd., (Calcutta and Simla).  
 Tripathi & Co., Book-sellers, Princess Street, Kalbadevi Road, Bombay, Messrs. N. M.  
 University Book Agency, Kachari Road, Lahore.  
 Upper India Publishing House, Ltd., Literature Palace, Ammuddaula Park, Lucknow.  
 Varadachary & Co., Madras, Messrs. P.  
 Venkatasubban, A., Law Book-seller, Vellore.  
 Wheeler & Co., Allahabad, Calcutta and Bombay, Messrs. A. H.  
 Young Man & Co., Egerton Road, Delhi.

\*Agents for publications in Aviation only.

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[This Report is printed on paper made in the Paper Pulp Section of the Forest Research Institute, Dehra Dun, from *Saccharum munja*.]

# FOREST RESEARCH IN INDIA, 1936-37.

## PART I.—THE FOREST RESEARCH INSTITUTE.

### CHAPTER I.—GENERAL REVIEW.

The immediate value of investigations has, as hitherto, received special attention. Every effort has been made to keep in close touch with Provincial Forest departments. The value of research has long been recognised throughout the world and research in subjects connected with forestry is of special importance in India where the forests are so largely the exclusive property of the State.

The number of enquiries received continues to increase. With a few exceptions the enquiries are of a practical nature and are received from all over the world, a fact which shows that the value of the work at this Institute is widely recognised.

His Excellency the Viceroy and Lady Linlithgow paid a visit to the Institute during the year and at the end of their visit their Excellencies expressed their approval of all they had seen. The Hon'ble Sir James Grigg, Finance Member, and Sir Girja Shankar Bajpai, Secretary, Education, Health and Lands, also inspected the Institute during the year.

Among numerous visitors to the Institute mention must be made of Mr. Mellor, Managing Director, Messrs. The Titaghur Paper Mills Co., Ltd., who came to discuss the progress of research on problems which are being investigated for the paper industry, and Mr. G. Ullstrom of Mekaniska Werrstad Karlstad (Sweden) deputed by Messrs. The Orient Paper Mills Co., Ltd.

One of the important items of the year's work was the forest exhibit at the Agricultural and Industrial Exhibition held at Lucknow during the cold weather of 1936-37. The details of this exhibit which was arranged in co-operation with the Forest department of the United Provinces are given in the report of the Utilisation Branch.

Another outstanding event of the year was the holding at Dehra Dun of the Utilization Conference in March 1937. The Conference lasted

4 days and some very useful business was transacted, not the least important of which were the discussions concerning the future policy to be adopted with regard to the timber development campaign. The proceedings of the conference and the resolutions passed are now in the press. Gentlemen attending the conference were afforded full facilities for seeing the research being carried out at the Institute.

*Silvicultural Branch.*—The year under review was a good seed year for most of the indigenous species under investigation in the Demonstration Area. The monsoon broke comparatively early and continued fairly uniformly till September followed by occasional winter showers. The atmosphere was generally damper than the previous year which accounts for generally better results under artificial regeneration. Frost was less severe than in the preceding years but bad enough to kill back most of the young teak. It has become necessary to close the All-India teak seed origin experiment after the current year's observations on account of repeated frost damage.

More up to date methods for ascertaining the best material for seed covering in the nurseries on the lines of investigations in foreign countries have been under experiment.

Different species of bamboos, *Morus alba*, *Aleurites fordii* and *A. montana* have been put out to restock failed teak areas.

On the statistical side, collection of sapwood data for deodar, stem and stump analyses of *Acacia catechu* were carried out and a note was written up on the formation of heartwood in deodar.

The erosion model in the Silvicultural museum has been highly appreciated by officers and the public both here as well as at the Lucknow Exhibition.

*Botanical Branch.*—The systematic study of the Indian *Terminalias* of the section *Pentaptera* and of five species of the family *Dipterocarpaceae* of forest importance was completed. Papers on three other Indian *Terminalias*, on a new genus of the *Connaraceae*, on the second part of recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain, on the oil-bearing seeds of the Chakrata, Dehra Dun and neighbouring Forest divisions, and on Indian plants reputed as fish poisons likely to yield efficient insecticides were also completed. The idea of conserving against change certain well-established botanical specific names of plants of forest importance was supported and a list of such names was submitted through the Imperial Forestry Institute, Oxford, to a Select Committee on Botanical Nomenclature for consideration. A large number of botanical specimens were identified during the year for Forest Officers and others in the provinces and advice given on technical matters. More than 2,500 specimens were incorporated in the Research Institute herbarium bringing up the total number to

near the quarter of a million mark. Donations and exchanges with other herbaria were continued as usual and suites of specimens sent out on loan to specialists engaged in the study of certain plant groups thus enhancing the value of our collections. Numerous samples of seed were supplied to many indentors in India and elsewhere and several larger indents for seed complied with.

The sal root disease, due to *Polyporus shoreae* and other associated fungi, was studied and an examination of specimens of the root rot and of cultural studies of the fungi was conducted. The roots of a number of local forest trees were examined in connection with the mycorrhizal investigation and mycorrhizal fungi were detected on sal and *Quercus incana*. Further progress was made in connection with the studies of the wood-rotting properties and pathogenic behaviour of fungi occurring on deciduous and coniferous trees. Inoculations on *Pinus excelsa* and *Cedrus deodara* with *Trametes pini* and *Fomes annosus* respectively showed signs of infection. Toxicity tests of certain wood preservatives were taken up and a beginning made with 'Ascu' preservative. Much progress has been achieved in the investigations relating to the life-history of various coniferous rusts in connection with which a large number of inoculation experiments were conducted and the biology of some of the stem and needle rusts of conifers have been worked out. Inoculation experiments made in connection with the investigations on *Dalbergia latifolia* canker fungus gave negative results. A large number of specimens of *Polyporaceæ* and species of *Armillaria* were incorporated in the Mycological herbarium which has also been enriched by the addition of several new and unrecorded rust specimens. Tours were made by the Mycologist in the Chakrata Forest division where valuable collections of fungi were made.

**Entomological Branch.**—An important part of the year's work was the study of the parasites of defoliators; especially of the defoliators of teak, sissoo and mulberry with a view to their multiplication and use in the biological control of these defoliators. This is the most important activity of the Entomological branch and it is hoped that practical results to forestry will be obtained from this work.

In continuation of the policy of publishing the accumulation of information available in our research files, a Forest Record on "The Biology of Bostrychidae" was published, this summarises all that is known of the Indian species of the family.

In systematic entomology steady progress has been made, over 700 species having been added to the reference collection. Special attention has been given to the weakest spot in systematics, the identification of immature stages, and several families of coleoptera were studied in detail. Much preliminary work has been done with lepidopterous larvae with the object of publishing the results in due course.

*Utilisation Branch.*—There are several important features worthy of special mention during the year under review. In the first place, the new Timber Development Section was inaugurated at the commencement of the year. This Section started its career by the Officer in Charge, Mr. S. Kamesam, making a tour to all provinces in India, with a view to finding out the best means of developing the timber resources of the country and collecting information on the output and sizes of the commercial woods available in the Provinces, and possible new markets for these woods. On his return, Mr. Kamesam proceeded to write up and issue a series of booklets on a variety of subjects connected with the utilisation of timber. Some 12 or more of these booklets have already been published and widely distributed.

On April 1st, 1937, the Timber Development Section was transferred to the Central Office under the direct control of the President of the Forest Research Institute.

Another important part of the year's work was that in connection with the Agricultural and Industrial Exhibition held at Lucknow during the cold weather of 1936-37. At a very late date it was decided that the Forest Research Institute should co-operate with the United Provinces Forest Department in staging a comprehensive exhibit consisting of an all-wood treated timber house of earthquake-proof design, together with displays of furniture of Indian woods and other exhibits illustrating the work of the Forest Department and the Forest Research Institute. In addition to the above, the Institute decided to erect two treated wood bridges (one being of 48 ft. span) as demonstrations of the possibilities of treated wood for such purposes. As time was very limited, the resources of the Branch were strained to the utmost in order to have the exhibits ready on the opening day, but it is satisfactory to report that the Forestry Court, including the treated timber house (which was of a two-storied design with 8 rooms), was one of the very few exhibits in the Exhibition which were ready on the opening day, when H. E. The Governor of the United Provinces made a personal tour of inspection through the house. At a later date, H. E. The Viceroy also visited the house and both Their Excellencies expressed their appreciation of this novel exhibit. The Forest Research Institute was awarded a Gold Medal for their exhibit and Mr. Kamesam received a Gold Medal for his work on Ascu.

In the other Sections, considerable progress was made on paper pulp and seasoning. The Paper Pulp Section was especially active during the year. This was the first year in which the Indian paper mills subscribed towards the expenses of the Section, and it is satisfactory to be able to report that considerable progress was made on the problems which were allotted to the Forest Research Institute by the Indian Paper Makers' Association. The investigations on the disintegration of bamboos

and that on Indian and foreign china clays were completed. The next investigation on the programme, namely the causes and prevention of discolouration in papers, was also started and is now well under way. Some very encouraging experiments were also carried out on the manufacture of kraft paper from bamboos, and the wood-pulp grinder for investigating the possibilities of manufacturing mechanical pulp from wood was installed towards the close of the year.

Another important investigation started by this Section was in connection with the suitability or otherwise of bagasse (crushed sugarcane) for making fibre boards for insulation and constructional purpose. A special grant was given by the Imperial Council of Agricultural Research to the Forest Research Institute to be used solely for this purpose.

The Seasoning Section was active in testing out the new furnace kiln and the oscillating process of kiln seasoning devised by Dr. Kapur. The laboratories of this Section have also been busy, and the evolution of a new type of cheap electric moisture metre was one result of their labours. Orders for more than a dozen of these metres were received immediately and arrangements were made for their manufacture locally at Dehra Dun.

The Timber Testing Section was fully occupied on routine testing and on special enquiries relating to such subjects as pole tests, the preparation of test pieces for aircraft purposes and the grading rules for teak squares.

The Wood Technologist, was, as usual, kept busy with numerous special enquiries and the routine work of timber identification and examinations for fungus.

The Woodworking and Veneer Sections worked at high pressure throughout the best part of the year, firstly in connection with the making and erection of the demonstration house, furniture, and bridges at the Lucknow Exhibition, and later trying to clear off the large accumulation of arrears of work which had piled up while the Exhibition work was in hand. Progress has been made towards interesting Indian commerce in the manufacture of high class hardwood veneers and it is hoped that such veneers will soon be available in India. Hardwood veneers of several Indian timbers are now on the European market. During the year there was a boom in Malabar rosewood especially in logs of a purple colour and very high prices were obtained. Some squares of U. P. Indian laurel (*Terminalia tomentosa*) were obtained to see what use could be made of this timber.

The activities of the Minor Forest Products Section had to be greatly reduced during the year. Nevertheless a considerable number of enquiries were dealt with and the cultivation of drug plants in the minor forest products garden was extended. A large number of enquiries

were received for scale drawings of the F.R.I. Portable Charcoal Kiln, and 34 sets of drawings were sent out in this connection.

The Utilisation Officer toured on the North Western Railway with the Inspector General of Forests, the Sleeper Control Officer, Northern Group, and the Timber Advisory Officer, in connection with the splitting of sleepers treated with water solutions. On this tour, many thousands of sleepers were examined in several different sections of the line, and a report on the whole subject was later published for departmental use. The Utilisation Officer also attended the Sleeper Pool Committee meeting at Delhi in November 1936, and went twice to Lucknow in connection with the Forest Department's activities at the Lucknow Exhibition.

*Chemical Branch.*—It was reported last year that the study of *Vitex negundo* and *V. peduncularis* had been taken up with a view to discovering the active principles responsible for the medicinal properties attributed to these plants in the Indian system of medicine. *Vitex peduncularis*, for instance, is a well known remedy for black water fever which is becoming more widely acknowledged by the medical profession. Our investigations have shown that it contains a glucoside and an alkaloid, the identity of which has not yet been established. From *V. negundo*, on the other hand, has been isolated a glucoside, constituents of which are glucose, parahydroxy-benzoic acid and an unidentified substance. To parahydroxy-benzoic acid may be attributed the antifebrile properties of this drug.

Of fish poisons under investigations the discovery of rotenone in *Millettia pachycarpa* is interesting and important.

The study of the indigenous sources of lauric acid, which has been mentioned in previous reports, has now been extended to *Litsaea chinensis*, the fat of which contains 93 per cent. of trilaurin. Another oil that has been investigated during the year is from the seeds of *Ximenia americana*. The discovery of a new fatty acid which, we have designated as Ximenic acid is of interest.

Under the heading of essential oils has been mentioned the pleasant smelling oil from *Osyris tenuifolia* which grows in East Africa. The oil is very similar in odour to sandalwood oil but the chemical investigation indicates that the quantity of santalol is very deficient compared to Indian sandal oil. The odour in this case is probably due to the related alcohols, the identity of which has not yet been established.

## CHAPTER II.—SILVICULTURE BRANCH.

## I. Experimental Silviculture.

## (i) NATURAL REGENERATION.

The study of annual seed production and fertility of individual *Anogeissus latifolia* trees (Expt. No. 44) was continued for the 9th year. All the trees produced a good crop of seed. Germination per cent. for the seed collected ranged from 0 to ·07.

Seed crops from individual trees of *Shorea robusta*, *Tectona grandis*, *Pinus longifolia* and *Terminalia tomentosa* were also observed and recorded. It was a good seed year for the first three species although much of the sal seed was blown away by wind before collection. Practically no *Terminalia tomentosa* tree under observation produced any seed.

## (ii) INVESTIGATIONS ON SEEDS.

(a) *Seed weighments and germination tests.*—During the year under report 126 weighments were made including 9 new species, and germination tests for 105 species were carried out. Some of their data were incorporated in the revised Forest Bulletin No. 41, which is now being issued as an Indian Forest Record, Silviculture Series, Vol. II, No. 5.

(b) *Seed storage.*—The following results of germination tests with seed stored for different periods in (i) sealed tins and (ii) gunny bags were obtained.

Species.	Date of collection.	Date of first test.	GERMINATIVE CAPACITY.									
			Fresh.	STORED IN TINS FOR				STORED IN GUNNY BAGS FOR				
				1 year.	2 years.	3 years.	4 years.	1 year.	2 years.	3 years.	4 years.	
				Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
<i>Acacia catechu</i>	June 1932	June 1932	67	25	2	Nil	..	1	Nil	..	..	
	February 1934	April 1934	56	14	6	..	..	..	..	..	..	
<i>Acacia modesta</i>	May 1933	June 1933	72	57	15	13	..	22	4	7	..	
<i>Adina cordifolia</i>	June 1935	June 1935	79*	291*	..	..	..	695*	..	..	..	
<i>Bombax malabaricum</i>	April 1932	May 1932	52	36	87	1	4	0.7	Nil	..	..	
	May 1933	August 1933	39	18	4	12	..	9	Nil	..	..	
<i>Cassia siamea</i>	March 1933	April 1933	1	..	..	..	..	4	10	..	..	
<i>Cedrela toona</i>	May 1935	June 1935	21	Nil	..	..	..	Nil	..	..	..	
<i>Chickrassia tabularis</i>	March 1933	April 1933	23	3	Nil	..	..	Nil	..	..	..	
<i>Celtis tetrandia</i>	September 1935.	October 1935	25	30	..	..	..	23	..	..	..	
<i>Dalbergia latifolia</i>	May 1933	June 1933	46	18	Nil	..	..	Nil	..	..	..	
<i>Diospyros tomentosa</i>	May 1935	May 1935	44	16	..	..	..	16	..	..	..	
<i>Dendrocalamus strictus</i>	May 1933	June 1933	65	73	76	49	..	0.6	Nil	..	..	
<i>Hovenia dulcis</i>	April 1935	April 1935	57	48	..	..	..	52	..	..	..	
<i>Melia azedarach</i>	February 1932	April 1932	65	90	71	68	54	69	2	Nil	..	
<i>Ougeinia dalbergioides</i>	May 1935	May 1935	47	Nil	..	..	..	Nil	..	..	..	
<i>Schleichera trijuga</i>	August 1932	August 1932	13	15	19	Nil	..	15	4	Nil	..	
<i>Terminalia arjuna</i>	May 1935	May 1935	67	14	..	..	..	40	..	..	..	
<i>Terminalia chebula</i>	February 1933	June 1933	Nil	0.7	0.3	Nil	..	1.3	0.7	Nil	..	

\* per 1/4th oz. of seed.

Similar storage tests have been commenced during the year for *Acacia arabica*, *Morus alba* and *Swietenia macrophylla*.

### (iii) INVESTIGATION ON SEEDLINGS.

The morphological seedling studies as reproduced in Troup's *Silviculture of Indian Trees* were completed for the following 11 species :—

*Cullenia excelsa*, *Diospyros tomentosa*, *Derris robusta*, *Ficus glomerata*, *Lophopetalum fimbriatum*, *Ola scandens*, *Olea cuspidata*, *Phæbe hainesiana*, *Pinus caribaea*, *Stereospermum xylocarpum*, and *Vitex peduncularis*. Sketches of the following four other species were also partly drawn :—*Altingia excelsa*, *Cynometra polyandra*, *Dichopsis polyantha*, and *Ichnocarpus assamicus*.

### (iv) INVESTIGATIONS ON TREES AND CROPS.

(a) *Seasonal course of height growth*.—The investigation was continued for 13 common Indian species,—weekly or periodical measurements being taken throughout the year.

(b) *Phenological data*.—Observations were recorded on 13 common species. Collaboration with the Provincial Silviculturists was continued. Their data are being analysed with a view to issuing a note on the subject.

(c) *Inheritance of individual characters*.—Two more experimental plots of reputed figured and unfigured *Terminalia crenulata* plants have been added to the two existing ones. *Pinus longifolia* plots, raised for determining whether high resin yielding capacity is a hereditary character, were maintained.

(d) *Inheritance of climatic racial characters*.—The All-India teak seed origin experiments dealing with 11 origins were maintained. Every plant was again frosted to the ground, and it has been decided to discontinue this set of plots at the end of 1937, after recording morphological differences between the plants of the different origins. Differences in appearance of bark and colour of foliage between Burma and local origins of *Acacia catechu* reported in previous years persisted throughout the year under report.

(e) *Inheritance of physiological race characters*.—The small plantations of different forms of *Butea* and *Schleichera trijuga* raised for examination for lac culture were more or less frosted again this year. As it has since been reported from Ranchi that it would not be possible to raise lac at Dehra Dun, morphological differences will only be studied.

(f) *Soil quality class indicators*.—The ecological quadrats in plantations of different important species in the Demonstration Area were maintained and mapping done as usual.

(g) *Congestion in bamboo clumps*.—Two different treatments namely topping and stripping of new culms were applied to selected clumps of *Dendrocalamus strictus* early in the cold weather to determine the effect on congestion of the clumps. These treatments are intended to simulate, under control, damage by elephants. It is too early yet to draw any conclusions.

(h) *Root competition*.—Experiments on the following species are in progress :—

*Shorea robusta*.—(a) The experiment was laid out in 1933. The figures for 1933-34 were analysed and the difference in diameters between two treatments, viz., control and elimination of root competition indicated a significant increase in diameter growth in the plots where root competition was eliminated. Subsequent measurements are being analysed at the Statistical Laboratory, Calcutta, by up to date methods.

(b) Line sowings of sal were done at right angles to the East to West edge of a crop of big sal poles in 1933. The lines were 6 feet apart, and were sown thinly and thickly alternately, to study the effect of competition between seedlings themselves. Alternate pairs of lines have been trenched annually to a depth of 18" cutting through all roots from the adjoining wood. Data are under computation.

*Pinus longifolia*.—Same as sal (a) above. The data have not been worked out yet.

*Cedrela toona*.—Comparable pairs of young plants growing under the same conditions were selected in 1936. The root competition from the surrounding growth was eliminated by trenching all round one of the plants in each pair and isolating them by galvanised iron.

*Phaëbe lanceolata*.—As *Cedrela toona* above.

*Holoptelea integrifolia*.—Same as *Cedrela* and *Phaëbe* above except that this has been trenched in sets of three plants.

*Results*.—No significant differences in growth were observed in the case of *Cedrela toona* and *Holoptelea integrifolia*. The *Phaëbe* measurements were upset by insect attack.

(i) *Thinnings in young plantations*.—The five sets of experiments in replicated series in the younger *Pinus longifolia* plantations in the Demonstration Area were maintained. The factors under investigation are (i) comparison of different grades and methods of thinning (C-grade, D-grade and "free thinnings"), (ii) to compare the effects of different

dates of first thinning, (iii) comparison of the effects of different early espacement on growth and form, (iv) comparison of thinnings to different fixed numbers of stems per acre, and (v) comparison of different thinning cycles. It is too early to report any results so far.

(j) *Pruning versus natural cleaning*.—Two investigations in *Shorea robusta* and *Pinus longifolia* crops to compare the effects of pruning *versus* natural cleaning on growth and timber quality are in progress.

(k) *Twist in Pinus longifolia*.—The experiments of (a) attempting to induce twist and (b) studying the heredity of twist in *Pinus longifolia* are being continued. Plants raised from X-rayed seed are progressing and will soon be large enough for observation of twist.

(l) *Controlled burning*.—An experiment is in progress to determine the effects of early burning in young *Pinus longifolia* plantations.

#### (v) ARTIFICIAL REGENERATION.

Weather conditions affecting the results obtained were as follows:—

The 1935 monsoon arrived rather late, the first showers falling on the 2nd July. Rains were, however, regular up to the 3rd week of September. Then followed a dry period and there was practically no rain up to the beginning of February 1936.

The 1936 monsoon broke much earlier than usual, in the beginning of June, and continued up to the end of September. Thus the plants had a much longer rainy period than usual. There were copious winter rains also in December when the winter stump planting was done. Frost occurred, as usual after the winter rains, but was not as severe as in the last few years. On the whole it was a damp year.

(a) *Line sowings*.—The following species were tried in the open as well as in shade during 1936:—

*Albizia stipulata*, *Boswellia serrata*, *Cordia myza*, *Eugenia jambolana*, *Kydia calycina*, *Lannea grandis*, *Morus alba*, *Swietenia macrophylla* and *Terminalia myriocarpa*; of these *B. serrata* and *T. myriocarpa* failed; the others did well. Plants were more or less affected by frost, especially those of *S. macrophylla*.

(b) *Rains entire planting in the open*.—The following species were tried in 1936. The survival per cent. at the end of the year is given in brackets. The plants have not yet been through a hot weather. *Cedrela toona* (74), *Holoptelea integrifolia* (78), *Lagerstramia parviflora* (55), *Morus alba* (82), *Machilus gamblei* (96), *Swietenia macrophylla* (6) and *Terminalia citrina* (96).

For the species planted in 1935, the following are the survival per cent. at the end of the 1st and 2nd growing seasons respectively. *Boswellia serrata* (8-0), *Cedrela toona* (61-closed), *Cordia myxa* (84-58), *Diospyros tomentosa* (78-55), and *Terminalia paniculata* (56-36). Casualties in the first two species were mainly during the hot weather.

(c) *Rains entire planting in cleared lines under shade.*—The following species were planted in 1936,—the survival per cent. at the end of the year being given in brackets.

*Cedrela toona* (69), *Holoptelea integrifolia* (59), *Lagerstramia parviflora* (11), *Lophopetalum fimbriatum* (99), *Morus alba* (82), *Machilus gamblei* (98), *Swietenia macrophylla* (62), and *Terminalia citrina* (92).

As regards the species tried in 1935 the following are the survival percentages at the end of the first and second growing seasons respectively :—

*Cedrela toona* (58-46), *Cordia myxa* (98-98), *Cryptomeria japonica* (33-29), *Diospyros tomentosa* (80-68), *Terminalia paniculata* (62-52) and *Boswellia serrata* (0). The last species died on account of heavy rains and drip soon after planting.

(d) *Winter entire planting in the open and under shade.*—Of the species planted out during February 1936 only *Terminalia chebula* survived in the open 66 per cent. at the end of the first season. The other two species *Pterospermum acerifolium* and *Boswellia serrata* died during the hot weather of that year.

The following species were put out during February 1937 :—

*Anthocephalus cadamba*, *Eugenia grandis* and *Morus alba*.

(e) *Winter stump planting in the open and in cleared lines.*—At the end of the 1st growing season, the survival percentages for *Acacia catechu*, *Prosopis juliflora*, *Stereospermum suaveolens* and *Terminalia tomentosa* tried in 1936, were 26, 34, 98 and 54 in the open.

The following species were planted during 1936-37 cold weather:—

*Acacia modesta*, *Cassia siamea*, *Hovenia dulcis*, *Litsaea polyantha*, *Mallotus philippinensis*, *Swietenia macrophylla* and *Terminalia paniculata*.

(f) *Rains stump planting in the open.*—The species put out in 1935 are mentioned below with their survival percentages at the end of the 1st and 2nd seasons respectively :—

*Boswellia serrata* (38-48), *Bauhinia purpurea* (96-94), *Grevillea robusta* (92-76), *Lagerstramia flos-reginae* (100-97), *Juglans*

*regia* (95-closed), *Prosopis spicigera* (90-64), *Pongamia glabra* (100-80), *Terminalia chebula* (100-22), *Terminalia myriocarpa* (12-closed), and *T. arjuna* (4-closed). Of these *Juglans regia* died of frost and subsequent drought, and *Terminalia myriocarpa* of frost alone.

With the species tried in 1936 the following results were obtained at the end of the year, the figures in brackets giving the survival per cent.:—

*Cassia siamea* (100), *Cedrela australis* (100), *Cordia myxa* (100), *Hovenia dulcis* (44), *Lagerstræmia parviflora* (98), *Prosopis spicigera* (99), *Pterospermum acerifolium* (100), and *Terminalia paniculata* (98).

(g) *Rains stump planting under shade*.—The species put out in 1935 showed the following survival percentages at the end of the 1st and 2nd seasons respectively :—

*Bauhinia purpurea* (70-68), *Grevillea robusta* (55-35), *Lagerstræmia flos-reginae* (100-98), and *Pongamia glabra* (98-44). Experiments with other species mentioned in the last year's report were closed down as the plants had either died in the 1935-36 frost or in the subsequent dry weather. The following species were tried in 1936, their survival per cent. at the end of the season being given in brackets :—

*Cassia siamea* (68), *Cordia myxa* (98), *Eugenia grandis* (65), *F. operculata* (99), *Hovenia dulcis* (70), *Lagerstræmia parviflora* (96), *Pterospermum acerifolium* (98), *Soymida febrifuga* (20), *Terminalia paniculata* (80), and *T. tomentosa* (88).

(h) *Storage of stumps before planting*.—The 1935 experiments with *Acacia catechu* and *Eugenia jambolana* stored in moist sacking under thatch shelter for 0, 4, 7, 10 and 13 days shewed the following results at the end of the 2nd growing season :—

*Acacia catechu*.—The survival percentages were 56, 46, 32, 20, and 22, with corresponding average heights of 40·6", 37·9", 36·8", 39·5" and 29·5".

*Eugenia jambolana*.—The survival percentages were 68, 90, 86, 80, and 80 with corresponding average heights of 10·6", 10·4", 11·4", 10·7" and 10·3".

In 1936, *Cedrela toona* and *Terminalia tomentosa* were tried under similar conditions.

*Cedrela toona*.—250 stumps of different diameters prepared on 14th June 1936 were planted out in comparable sets of 50 stumps after storage

up to 13 days in moist sacking under thatch shelter. Rain was rather irregular up to 20th June 1936 but was continuous thereafter. At the end of the growing season the survival percentages were 98, 100, 96, 100, and 94 with corresponding average heights of 10.3", 11.5", 13.2", 12.6", and 11.6" for stumps stored for 0, 4, 7, 10 and 13 days respectively.

*Terminalia tomentosa*.—The number of stumps and the initial treatment were the same as for *Cedrela toona* but the date of preparing the stumps was 22nd June 1936. At the end of the year the survival percentages were 76, 78, 68, 72 and 68 with corresponding average heights of 6.6", 8.2", 7.4", 7.4" and 8.0" for stumps stored for 0, 4, 7, 10 and 13 days respectively. Rains were continuous up to the end of the month.

(i) *Early planting of stumps without irrigation*.—The fortnightly planting of 25 *Acacia catechu* stumps was started from 10th January 1936 in the open and continued up to 11th June 1936. The survival percentages were 8, 8, 8, 36, 12, 12, 0, 0, 12, 76, 100, and 88 with corresponding average heights of 32.5", 38.5", 34.0", 24.4", 34.7", 32.7", 0, 0, 24.7", 23.9", 27.3" and 19.9" for sets 1 to 12 respectively. Some occasional showers during the hot weather account for the varying results. The driest month was April and planting during this month was a complete failure. Planting done just before or at the break of the monsoon gave the best results.

(j) *Comparison of nursery stock and natural seedlings*.—The 1935 experiment with *Eugenia jambolana* showed survival percentages of 70 for nursery and 68 for forest plants with heights 10.3" and 8.6" respectively at the end of the 2nd season as against the survival percentage of 96 and average height of 7.6" in the first year for both the sets. *Eugenia jambolana* was again repeated in 1936 and the survival percentages at the end of the year were 98 and 68 for nursery and forest plants respectively with no significant difference in their heights. It appears from the above that, if transplanted, forest plants suffer by comparison with plants raised in the nursery.

(k) *Comparison of nursery and forest stumps*.—*Bauhinia variegata* planted in 1935 shewed the survival per cent. of 98 for nursery grown stumps and 80 for forest stumps, their average heights being 23.2" and 19.5" respectively at the end of the 2nd season.

The experiment was repeated with *Bauhinia variegata* and *Eugenia jambolana* in 1936. The survival per cent. of *B. variegata* was 100 for nursery stumps and 94 for forest stumps with average heights of 13.7" and 7.6" respectively at the end of the year. *Eugenia jambolana* shewed a survival per cent. of 100 for nursery stumps and 98 for forest stumps with average heights of 5.3" and 6.1" respectively at the end of the season.

(1) *Comparison of sowing, transplanting and stumping.*—The species tried from 1934 to date and the results obtained are summarised below:—

Year of planting or sowing.	Species.	Method (sowing or planting).	SURVIVAL PER CENT. AT THE END OF THE YEAR			Average height at the end of 1936 (Inches).	REMARKS.
			1934	1935	1936		
1934	<i>Eugenia jambolana</i>	Direct sowing	93	5	..	..	Discontinued in June 1936 as survival was below 20 per cent.
		Entire transplanting	60	..	..	..	
		Stump planting	78	33	..	..	
	<i>Stereospermum suaveolens.</i>	Entires in crow-bar holes.	53	8	8	4.7	
		Entire in standard pits	60	13	15	3.3	
1935	<i>Acacia catechu</i>	Stump planting	98	100	100	30.7	
		Direct sowing	..	83	75	32.0	
		Entire transplanting	..	63	45	24.4	
	<i>Bombax malabaricum</i>	Stump planting	..	78	65	33.7	
		Direct sowing	..	70	..	..	
		Entire transplanting	..	93	50	6.0	
	<i>Cedrela toona</i>	Stump planting	..	90	90	15.1	
		Entire transplanting	..	95	10	26.5	
	<i>Pterospermum acerifolium.</i>	Stnmp planting	..	100	60	33.4	
		Direct sowing	..	88	..	..	
Entire transplanting		..	100	..	..		
1936	<i>Acacia catechu</i>	Stnmp planting	..	65	..	..	Discontinued in June 1936 as survival was below 20 per cent.
		Direct sowing	..	..	95	12.5	
		Entire transplanting	..	..	70	6.7	
	<i>Bombax malabaricum</i>	Stump planting	..	..	88	19.4	
		Direct sowing	..	..	100	5.6	
		Entire transplanting	..	..	95	3.9	
	<i>Cedrela toona</i>	Stump planting	..	..	98	8.5	
		Direct sowing	..	..	80	3.8	
		Entire transplanting	..	..	95	4.4	
	<i>Celtis tetrandia</i>	Stump planting	..	..	100	18.9	
		Direct sowing	..	..	80	6.6	
Entire transplanting		..	..	88	14.7		
		Stump planting	..	..	100	15.7	

(m) *Araucaria plantations.*—The *A. cunninghamii* plantation is continuing well and has reached a maximum height of 12'-6" at the end of 5 years.

Plants of *A. bidwillii* mixed with *Pinus longifolia* have attained a maximum height of 12'-3" at the end of 7 years. One more plot has been planted up with this species during the year.

Although both the species started to grow very slowly initially, they have since become well established and look promising.

#### (vi) NURSERY WORK.

The seed crop in the forests of the Dun valley was moderate during the year. Stock of various species was raised for use in the Experimental garden and Demonstration area.

The following experiments were carried out in the nursery during the year :—

(a) *Experiments with different degrees of nursery bed shades* (Experiment 14) were repeated with *Adina cordifolia* and *Anthocephalus cadamba*.

*Adina cordifolia*.—The general indication from results obtained was the same as in previous years, except that there was more damping off than usual owing to heavy and continuous rains. Stocking and development were best under tin shade, fairly good under thatch, poor under batten, and worst in the open.

*Anthocephalus cadamba*.—The development of seedlings in general was much better than last year. Germination, stocking and development were the best under batten shade, good under tin, fairly good under thatch and poor and patchy in the open,—thus practically confirming last year's results except that results under thatch shade were better than under tin last year.

(b) *The manuring experiment (No. 16) in nursery beds* having the same past history was carried out with pre-germinated seed of *Terminalia tomentosa*. *Crotalaria juncea*, *Cassia tora* and *Lucerne* were again used this year as green manure in three different beds, whereas artificially prepared farmyard manure was added to two other beds separately at the rate of 10 and 20 baskets per bed. One separate bed was kept as control. The number of seedlings used for the nursery beds was the same in all cases. The survival per cent. and the average height for each kind of manure are as given below :—

Manure.	Survival per cent.	Height in inches.	REMARKS.
Artificial farmyard—			
10 baskets . . . .	97.1	10.6	Variation in results is probably more influenced by local soil variation than by the manure. True results will only be apparent after several repetitions in the same beds.
20 baskets . . . .	90.6	8.8	
<i>Crotalaria juncea</i> . . . .	96.5	9.3	
<i>Cassia tora</i> . . . .	90.0	6.5	
<i>Lucerne</i> . . . .	84.7	5.9	
Control . . . .	91.4	10.5	

This year 10 baskets of artificial farmyard manure seemed to have given the best results so far ; and the green manuring of *Crotolaria juncea* was decidedly better than that of *Cassia tora* and *Lucerne*.

(c) *Best material for seed covering in nursery* (Experiment No. 92).—With a view to study what easily available material is most efficacious as regards quickness and uniformity of germination of different types of seeds, the following were used :—

#### *Materials—*

- A. Well washed coarse sand.
- B. Sifted leaf litter.
- C. Artificial farmyard manure.
- D. Sifted nursery soil (control).

#### *Seeds—*

1. *Cedrela toona*.
2. *Terminalia arjuna*.

Sowing was done on 10th June 1936 for No. 1 and 13th May 1936 for No. 2.

#### *Technique—*

The seed covering materials were laid in replicated plots. For *Cedrela toona* A, B, C coverings were  $\frac{1}{8}$ ",  $\frac{1}{4}$ " and  $\frac{1}{2}$ " thick respectively and D,  $1\frac{1}{2}$  times the seed thickness ; but, for *Terminalia arjuna* all the coverings were  $\frac{1}{8}$ " thick. *Cedrela toona* was uniformly sown in lines using equal quantities of seed whereas seeds of *T. arjuna* were counted and equal numbers used in each unit. The experiment was combined with shading so that 4 of the beds were shaded and 4 unshaded using a latin square layout.

*Results.*—The following results were obtained up to the end of the year :—

*Terminalia arjuna.*—Germination per cent. was better in the unshaded beds on the whole, but sifted leaf litter in the shaded set gave the best results. There was, however, very little difference in the germination per cent. obtained with the different coverings as is to be expected with a large seed. Height growth by the following cold weather was better in the unshaded beds, and especially so in the case of B (leaf litter covering) and C (artificial farmyard manure).

*Cedrela toona.*—Germination was uniform and development better in the shaded beds. Coarse sand gave the best results in the open and leaf litter in the shade. Survivals were very definitely better (2 to 4

times as many) in the shade than in the open. Coarse sand gave the best survivals and ordinary nursery soil next best in both shade and open. Height growth at the end of the year was more or less the same for all coverings with or without shade.

The experiment is being repeated.

#### (vii) MISCELLANEOUS.

A small plantation of *Broussonetia papyrifera* and one of *Hovenia dulcis* have been raised in the Experimental garden,—the former for testing for paper pulp and the latter for studying the natural cleaning of branches and straightness of the bole under plantation conditions.

#### (viii) RECLAMATION AND AFFORESTATION.

(a) *Miscellaneous Working Circle*.—Compartments with *Tectona grandis* which have failed on account of frost year after year are being re-afforested with *Acacia catechu*, *Bambusa polymorpha*, *Cedrela toona*, *Dendrocalamus strictus*, *D. longispathis* and *Morus alba*, and up till now 14 such compartments have been completed. All these are found to be frost bardy in this locality, especially the last named species.

*Dendrocalamus strictus* was sown in lines supplemented by planting of nursery plants pruned at 2 ft. length of the stems. *D. longispathis* was transplanted at 10'×10' from the nurseries, stems having been pruned at a height of 2 ft. as in the case of *D. strictus*. *Bambusa polymorpha* was sown in lines. Germination was excellent and plants at the end of rains were up to 1 ft. in height.

The rosewood plantation in two adjoining compartments has been regularly pruned. This forms a small compact promising block of rosewood.

Plants of *Aleurites fordii* and *A. montana* have been raised successfully in a small *taungya* plot in one of the cleared compartments. Preliminary trials with *Pinus caribaea* by transplanting 3 months old seedlings were not successful chiefly owing to damping off during the rains. A 15-acre plot, now under *taungya* crops, will be stocked with *Pinus longifolia* in 1937 rains to raise crops for an extensive replicated set of thinning experiments. Five more compartments have been leased out for *taungya* cultivation and will be used for further trials with new species.

(b) *Sal Working Circle*.—Mixed line sowings of *Dalbergia sissoo*, *Dodonea viscosa* and *Bauhinia* spp. were made in compartments where young sal was suffering from frost, the main idea being to cover the ground with quick growing frost hardy species so that these might

afford the existing sal protection in the future. Frost occurred this year as usual, but damage was limited to small and unprotected plants only.

(c) *Chir* (*Pinus longifolia*) Working Circle.—Blanks in the compartments with Naini Tal origin and in the plot in front of the Branch officers' hungalows (Nos. 14-16) were filled in with fresh sowings. The latter is well stocked now. The 'tin planting' method of South Africa was also tried here. Kerosene tins were cut in halves and these were filled with proper media placed on a platform, and *chir* grown in them. The plants were shaded and watered with a fine rose. When seedlings were sufficiently big the tins were taken to the planting site and planting done direct or with cakes of earth. The results so far are encouraging, giving 97 per cent. survivals at the end of the year.

A C-grade thinning was done in some of the earliest plantations and a mechanical thinning with a 6' stick-gauge was tried in one of these compartments, resulting in a fairly even espacement of 9'  $\times$  9' on the average. A number of compartments are under thinning research experiments in this circle.

## II. Statistical Section.

### (i) YIELD TABLES.

The total number of sample plot files maintained during the year is 1656, which shows an increase of 119 plots over last year's figures. Out of these, 19 sample plots were received from Hyderabad division (Sind) and the rest were shared by all other provinces, including Kashmir State.

Out of a total number of 309 sample plot files received for routine computations from different provinces only 240 were computed during the year.

Sapwood measurements were taken on 474 deodar trees in Lower Basbahr division. The results have been computed and written up for publication. Five deodar sample plots in Simla (now Lower Basbahr) division were remeasured and computed and 17 comparative thinning sample plots in *Shorea robusta* crops were laid out by the Forest Research Institute in Dehra Dun division.

Some sapwood data of sal were received from the United Provinces and analysed but the results were not found suitable for publication.

Two statistical field parties were sent to the Terai and Bhabar Estate division for collecting the khair (*Acacia catechu*) data on stump and stem analyses, and the computation has been completed.

## (ii) MISCELLANEOUS.

A note on the Formation of heartwood in Deodar was prepared by the Statistical Assistant Silviculturist and submitted for publication. Some tests on the precision of the standard sample plot method of determining basal area, height and volume per acre by means of sample trees were made by measuring up clear-felled plots. The results were published in the *Indian Forester* of January 1937, and showed that the standard method gives results that are generally accurate within  $\pm 5$  per cent. if reasonable care is taken in the selection of sample trees.

## III. Miscellaneous.

## (i) PUBLICATIONS.

A Manual of Indian Silviculture, Part I, was written by Mr. H. G. Champion and is now in the press.

## (ii) PHOTOGRAPHIC SECTION.

Due to the ever increasing demand for photos and slides, etc., by the provinces including exhibition authorities, and to changes of photographers who have been always in the temporary establishment, heavy arrears of work have accumulated in the photo section, although every effort is being made to reduce arrears as much as possible with the present limited staff.

The routine work carried out compares with previous years as follows :—

Year.	Negatives made.	Prints made.	Lantern slides made.	Colour Photos.
1933-34 . . . . .	1,095	2,271	400	..
1934-35 . . . . .	932	3,420	130	18
1935-36 . . . . .	748	2,791	301	6
1936-37 . . . . .	916	4,213	163	27

Of the new negatives 28 were the photos taken by Mr. Champion in Almora, etc., and 130 were photos taken by the Silviculturist during his tours, in Bengal, the Punjab and the Central Provinces.

398 photos were taken in the Timber Testing Section and 251 were taken for different Branches and Sections of the Institute.

89 negatives from the Silviculturist, U. P., and two negatives from Mr. Pring, Punjab, were received and added to the collection.

The total number of prints in the general series comes to 3,798 and in the specific series 4,529, against 3,529 and 4,341 respectively for the last year.

1,278 prints were prepared for different provinces and states and 164 were made for reproduction in various publications.

66 lantern slides were prepared and added to the Forest Research Institute collection.

17 Stereo photographs were added during the year bringing the total up to 108.

### (iii) RECORDS.

Large arrears have been cleared off this year by appointing a temporary extra typist in the ledger section. All English periodicals have been ledgered up to date, but the foreign periodicals are still 6 months in arrears. Much of the ledgering has been done by titles only, due to the lack of time and staff.

Abstracts of all Indian forest literature were prepared as usual for five agencies in India and abroad.

45 new books and working plans were added to the library during the year bringing the total to 719 with 546 bound volumes of periodicals. A list of additions with brief abstracts was circulated to provinces as usual.

There are 1,277 specific and 470 general ledger files out of which 42 new specific and 24 new general files were added to the collection during the year under report.

### (iv) WORKING PLANS.

Notes were written on the Jhansi, Damoh (Central Provinces) and Northern Shan States plans and the suggestions made thereon have been generally adopted in the plans.

### (v) MUSEUM.

Progress in the Museum was limited owing to the absence of the Museum Artist for two long periods, namely for about one month when his services were lent to the Punjab for preparing an erosion model for agricultural shows and for four months when he erected and demonstrated a model to illustrate erosion of denuded areas by rainfall at the Lucknow Industrial and Agricultural Exhibition. The erosion model in the Silvicultural Museum at the Forest Research Institute was dismantled for this purpose, but a duplicate travelling model is now being made.

The model to illustrate the influence of local climate on vegetation, the phenomena of altitudinal zonation, succession and retrogression, and the effects of site and soil is about half finished. Some improvements have also been made to the earlier models.

#### (vi) STAFF.

Mr. H. G. Champion, the late Silviculturist, toured in Kumaon and Chakrata during the hot weather of 1936. He reverted to his province and was succeeded by Mr. M. V. Laurie on the 6th October 1936. Mr. Laurie was on tour in Bengal, the Central Provinces and the Punjab during the year.

The President wishes to record his appreciation of Mr. Champion's services to Indian silviculture during his long service at the Institute.

#### (vii) VISITING FOREST OFFICERS.

According to the scheme for a Research Demonstration course several forest officers visited the branch to discuss their local silvicultural problems and research methods. Among them were Mr. K. P. Sagreya, Silviculturist, C. P., Mr. I. D. Mahendru, Assistant Silviculturist, Punjab, Mr. C. W. Kermode, Silviculturist, Burma, Messrs. Sant Ram and Jalmeja Singh Majithia from the Punjab, Mr. S. S. Negi and Mr. Ford-Robertson from the United Provinces.

Mr. E. J. Strugnell from the Forest Research Institute, Kuala Lumpur, Malaya, also visited the Institute in the course of a tour in India arranged for him by the Silviculturist.

## CHAPTER III.—BOTANY BRANCH.

**Systematic Botany.**

The systematic study of the Indian *Terminalias* of the section *Pentaptera* was completed and submitted for publication in *Indian Forest Records*. This section comprises trees of economic importance and an attempt has been made to understand the species of the older authors and to clear up some misunderstanding in this difficult group in which four species with three varieties and nine forms are recognised. A note on their botanical history with keys to the species, varieties and forms and descriptions of them and their distribution and occurrence as represented by herbarium collections is given.

A paper dealing with the following five species of the family *Dipterocarpaceae* was completed and submitted for publication also in *Indian Forest Records*: *Hopea helferi* (Dyer) Brandis, *Hopea oblongifolia* Dyer, *Shorea floribunda* (Wall.) Kurz, *Shorea assamica* Dyer and *Shorea sericeiflora* Fisch. & Hutch. These trees, which are of some economic importance, are illustrated and described, in some cases completely for the first time, and notes regarding their distribution, occurrence and field characters are given.

A paper on a new genus of *Connaraceae*, *Schellenbergia*, from Burma and one on three species of Indian *Terminalias*, covering the two confused species *T. catappa* Linn. and *T. procera* Roxb. and the little-known species *T. burmanica* King from Upper Burma was published in the *Indian Forester*.

The second part of "Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain" by Mr. Mukat Behari Raizada was published in the *Journal of the Indian Botanical Society*, Vol. XV (1936), pp. 149-167. The object of these papers, which are in the nature of supplements, is to make any amendments that may appear necessary and to put on record changes that may be noticed in the flora from time to time so as to keep it as up-to-date as possible for the convenience of those that use the flora and to facilitate revision.

In collaboration with the Chemistry Branch of this Research Institute, Part I of the Minor Forest Products of the Chakrata, Dehra Dun, Saharanpur and neighbouring Forest Divisions, The Oil Bearing Seeds, was published during the year. The second part, dealing with Drug yielding plants, was taken up and considerable progress made.

A paper on Indian Plants reputed as Fish Poisons was submitted for publication in the *Indian Forester* by Mr. Mukat Behari Raizada in collaboration with Mr. B. S. Varma of the Chemical Branch of this Institute. The object of this paper is to furnish information regarding Indian plants likely to yield efficient insecticides the demand for which has greatly increased during recent years.

The question of the conservation of certain botanical specific names of plants of economic importance has recently been taken up. At the instance of Prof. R. S. Troup, Director of the Imperial Forestry Institute, Oxford, supported by five Forestry Societies and Institutions in Great Britain, by the Inspector General of Forests, India, on behalf of the Forest Research Institute, Dehra Dun, and the Forest Department in India, and by the National Institute of Sciences of India, a motion to make provision for such conservation in the International Rules of Botanical Nomenclature was submitted for consideration by the Sixth International Botanical Congress that met in Amsterdam in 1935. The principle of such conservation was not accepted by the Congress but a compromise was effected by the appointment of an International Committee to draw up a list of the names of economic plants affected or likely to be affected by change, to be stabilised for ten years. It is thought that a list which is stabilised for ten years will probably remain in permanent use. A list of well-established names of Indian trees of forest importance for which changes have been recently made or proposed was drawn up and submitted to Dr. Burt Davy of the Imperial Forestry Institute to be placed before the Committee for consideration.

A certain amount of work was done in connection with the collection of botanical material and the study of the two South Indian species of *Dipterocarpus*, *D. indicus* Bedd. and *D. bourdillonii* Brandis, and in the preparation of a note on the field characters of some Indian and Burmese bamboos.

*Identification of specimens.*—In addition to the 670 plant specimens identified for Forest Officers and others in India, about 600 specimens, collected by the Forest Botanist and his assistant during their tours in the Chakrata forest division, were also examined and determined for incorporation in the herbarium and distribution to other herbaria, bringing the total up to 1,270; this number falls short of that of the previous year owing to the absence of the Forest Botanist on leave for four months during which time the work of identification was done by only one assistant who has numerous other duties to attend to; a number of specimens have therefore been left over to be identified during the ensuing year. As has been mentioned in the previous year's report the identification of specimens received from Forest Officers and others in India is done in the nature of routine work and as, in many cases, this is of a critical nature it cannot be hurried and takes up a great deal of the time of the Forest Botanist and his assistant.

Among the most notable collections received for identification are those sent in by Messrs. H. F. Mooney; J. S. Owden, Conservator of Forests, Bihar; V. S. Rao, Deputy Conservator of Forests, Bengal; and J. N. Sen Gupta, Assistant, Silvicultural Branch, who brought with him a collection of plant specimens from the Andaman islands.

*Herbarium*.—The number of specimens incorporated during the year amounted to 2,586; during the last eight years, including the year under review, 25,479 specimens have been added to the herbarium which, with the number estimated to be in the herbarium on the 1st January 1929, *i.e.*, 220,000, now brings the total to near the quarter of a million mark. Of the additions made during the year the following were obtained from other herbaria or botanical institutions by exchange or donation :—

Naturhistoriska Riksmuseet, Botaniska Avdelningen, Stockholm, Sweden . . . . .	478
Imperial Forestry Institute Herbarium, Oxford . . . . .	247
National Herbarium, Pretoria, South Africa . . . . .	120
Mr. Geo. L. Fisher, Houston, Texas, U. S. A. . . . .	125
Gray Herbarium, Harvard University, Cambridge, Mass., U. S. A. . . . .	100
Mrs. Agnes Chase, Bureau of Plant Industry, Smithsonian Institution, Washington, U. S. A. . . . .	60
Director of the Herbarium, Botanical Garden, Buitenzorg, Java . . . . .	2
Royal Botanic Garden, Calcutta . . . . .	97
<b>TOTAL</b> . . . . .	<b>1,229</b>

The principal other additions are from the collections made by the Forest Botanist and his assistant, chiefly from the Chakrata hills, from Mr. H. G. Champion, I.F.S., 153 specimens from Almora, Haldwani and Dehra Dun, and Mr. R. N. Parker, I.F.S., 38 Punjab specimens. The remainder is made up from the numerous smaller collections and individual specimens sent in by Forest Officers and others from the various provinces for identification.

The following specimens were distributed to other herbaria as donations or on an exchange basis :—

The Director, Royal Botanic Garden, Edinburgh . . . . .	182
Der Direktor, Botanischer Garten und Museum, Berlin-Dahlem, Germany. . . . .	148
The Forest Botanist, Maymyo Herbarium, Burma . . . . .	130
Mr. Geo. L. Fisher, Houston, Texas, U. S. A. . . . .	125
<b>TOTAL</b> . . . . .	<b>585</b>

Suites of herbarium specimens were sent to the following specialists for study in connection with the preparation of monographs or other publications with the result that several species new to science have been recognised and their descriptions, based on this material, will shortly be published; this incidentally greatly enhances the value of our material for further systematic study.

1. A selection of 66 sheets of *Ixora* from Burma and the Andaman islands to Dr. C. E. Bremekamp of the Herbarium and Botanical Museum

of the University of Utrecht. Dr. Bremekamp has from his study of this material raised the number of species of *Ixora* known to occur in Burma from 17 to 35 and in the Andamans from 3 to 7.

2. Eighteen sheets of *Tsuga* to Mons. H. Gaussen of the Laboratoire Forestier de Toulouse.

3. A hundred and eleven sheets belonging to the allied genera *Hydnocarpus*, *Taraktogenos*, *Asteriastigma* and *Gynocardia* to Dr. H. Sleumer of the Botanical Garden and Museum, Dahlem, Berlin.

4. The herbarium material of the genus *Impatiens* numbering nearly 800 sheets to the Director, Botanical Garden and Museum, Dahlem, Berlin.

The re-arrangement of the foreign (non-Indian) collections was continued throughout the year by the Herbarium clerk and progress was made from the *Podostemonaceae* to the *Gramineae* so that the arrangement is now nearly complete.

A series of portrait photographs of botanists who have been connected with the study of Indian Botany has been started; these portraits are hung in the Herbarium to which they form an interesting addition.

*Library.*—Seventy-eight books and seventy-six volumes of periodicals were added to the library during the year. A notable addition among these is the complete set up to date of 25 volumes et Additamenta 1-4 of the well-known and indispensable standard work on fungi, Saccardo's *Sylloges Fungorum*. The work of card-indexing items of systematic and other importance from the literature in the library was continued but could not be completed owing to pressure of other work.

*Tours.*—The Forest Botanist toured for about four weeks during the month of June in the Chakrata division during which the inoculation experiments that were being conducted by the Mycologist in connection with his biological studies of the coniferous rusts were seen and a collection of herbarium specimens made in quadruplicate for the Research Institute herbarium and for purposes of exchange with other herbaria. Mr. Mukat Behari Raizada, Lower Assistant, made a two weeks tour in the Chakrata hills during the month of September and brought in an interesting collection of nearly 300 specimens of autumn-flowering plants for our herbarium and for exchange; most of our collections from this area were made during the Spring and early Summer and this Autumn collection is a welcome addition to the herbarium.

The Mycologist toured in the Chakrata division during the months of May to July and September to October in connection with his investigations of the biology of the Himalayan coniferous rusts and the finding of their alternate hosts; during these tours a collection of specimens of fungi was also made for the mycological collection at the Research Institute;

Mr. Mukat Behari Raizada visited the All-India Ayurvedic Conference and Exhibition at Gurukul-Hardwar in March at the invitation of the Organising Secretary and exhibited a representative collection of about 250 Indian medicinal plant specimens in addition to other interesting exhibits from the Forest Research Institute; considerable interest was taken in these exhibits by those interested in obtaining genuine and unadulterated samples of Indian drugs.

*Seed supply.*—The list of seed offered on an exchange basis from plants grown in the Arboretum and Botanical Garden was, as in the previous year, distributed to the Provincial Forest Departments in India and, as usual, to various botanical institutions in India and abroad with which seed exchange relations are maintained. About 560 packets of seeds were supplied in response to the numerous requests received for the seed offered in the list the distribution of which has greatly increased the demand and it is with considerable difficulty that even a portion of the numerous requests can be complied with on account of our small staff. In addition to this about 35 larger indents for seed, aggregating nearly 4,600 pounds, were supplied. The seed mostly in demand being *Pinus longifolia* and *Pinus khasya* for the South African Forest Department, *Pinus khasya* for Snmatra, teak and *Eugenia*s for the Agricultural Department, Zanzibar, *Acacia arabica* for Java, *Platanus orientalis* for China, *Cedrus deodara* for Japan and *Sageraea listeri* and *Pinus caribaea* for trial in Indian provinces. Seeds of *Bambusa polymorpha*, *Phoebe hainesiana* and *Acacia arabica* and of various Indian trees were also obtained for the Central Silviculturist, Forest Research Institute, for his seedling studies.

*Botanical Garden and Arboretum.*—Work in the Botanical Garden and Arboretum continued to make good progress. The Botanical Garden is shaping well and attracts many visitors especially in the Spring and Autumn when the winter and rainy season annuals, which have been very successfully grown, are in flower. The lily garden has also been an attractive feature of the garden. The greenhouse and glasshouse were moved from the old Fruticetum and erected in the Botanical Garden and although completed rather late in the season the glasshouse has already been planted up with various interesting Cacti and Xerophytic plants and is already an interesting addition to the garden, while work on the planting up of suitable creepers for covering the frame-work of the greenhouse has already been done and good growth is expected during the coming rainy season. The rose garden was re-arranged and several new roses added to the collection. About 120 plants, representing 20 families and 34 genera, were planted out in the botanical garden and about 15 acres of lawn maintained. The brick lining of the feeder channels and the use of a series of galvanised iron troughs has proved both rapid and economical in irrigation

arrangements. A new tank of 1,296 cubic feet capacity was built near the south eastern corner of the garden.

In the experimental garden and nursery about 350 plants were raised for planting out in the Arboretum, Botanical Garden, in avenues and elsewhere and in addition a large number were also raised and distributed for planting in the residential grounds at New Forest in the adjoining Indian Military Academy and elsewhere.

The Arboretum is also being steadily added to nearly 100 plants representing 12 families and 15 genera having been planted out during the year. Two new avenues of quick-growing species, *Ailanthus glandulosa* and *Sapium sebiferum*, were planted out on the west side of the main building. Little or no damage was done by frost during the year as the winter was a comparatively mild one.

The following plants were recorded during the year to have flowered for the first time at New Forest:—*Sophora viciifolia* Hance, *Melia composita* Willd., *Sapium eugeniaefolium* Ham., *Amorpha glabra* Poir., *Anona cherimolia* Linn., *Xylia dolabriformis* Benth., *Alseodaphne keenanii* Gamble, *Pentstemon bradburyi* Pursh., *Catesbaea spinosa* Linn., *Stigmaphyllon puberum* A. Juss., *Spathodea campanulata* Beauv., *Zizyphus incurva* Roxh., *Dysoxylum binectariferum* Hk. f., *Cassia marginata* Roxh., *Cordia abyssinica* R. Br.

*Miscellaneous.*—As usual many enquiries on botanical subject received from Forest Officers and others in India were answered and advice given in botanical matters.

The death of Pt. Jagar Mani, Field Assistant, on the 4th January 1937 at his home in Garhwal, when on leave, is recorded with regret. Jagar Mani served in the Botanical Branch of this Institute for 29 years and accompanied several officers of this Branch on tours in India and Burma and made an independent collection in the Naga hills.

### Mycology.

*Sal root disease due to Polyporus shoreae and other associated problems.*—A large number of specimens of sal root rot from Bihar and Orissa were examined and a collection of sporophores of various types of *Polyporaceae* was made from the infected area, the chief ones among them being *Polyporus shoreae*, *Fomes tricolor* and *F. fastuosus*. Pure cultures of the two first-named fungi have been obtained and the cultural characters are being studied.

It is proposed to conduct a field study in the infected area as this has a bearing on the various diseases of sal and on the mycorrhizal problems the study of which was taken up during the year.

*Mycorrhizal fungi and associated problems.*—This investigation has been taken up recently. The examination of the roots of a number of local forest trees has revealed the presence of mycorrhizal fungi, and definite fungal mantles on the rootlets of sal and *Quercus incana* were found. Other forest trees will be examined for mycorrhizal fungi as time permits.

A critical histological examination of the material available was conducted.

*Die-back disease of Gmelina arborea.*—This has been kept in abeyance till the Peridermium investigation has been completed.

*Damping off disease of the forest tree seedlings.*—To be held in abeyance till the completion of the Peridermium investigation.

*Cultural studies of wood-rotting fungi and their pathogenecity.*—The cultures of a large number of fungi were maintained and data on the wood-rotting properties of several tropical *Polyporaceae* were recorded. It is now proposed to use these cultures for the toxicity tests of various wood preservatives and a beginning has been made with *Ascu*.

*Cultural studies of some fungi attacking coniferous trees and their pathogenecity.*—The inoculations on *Pinus excelsa* and *Cedrus deodara* with *Trametes pini* and *Fomes annosus* respectively showed signs of infection while those inoculated with *Armillaria mellea* remained abortive.

Cultures of various temperate wood-rotting fungi were maintained for study and sent abroad to other institutions.

*Biology of various coniferous rusts and experiments to find out their alternate hosts.*—

(a) *Peridermium himalayense* on *Pinus longifolia* and *Cronartium himalayense* on *Swertia* spp.—The third part of this work dealing with the results of inoculations on pine is almost complete. No further work is contemplated in this connection.

(b) *Peridermium indicum* on *Pinus excelsa* and *Cronartium* sp. on *Ribes rubrum*.—A draft paper on the biology of this rust was prepared and the necessary figures have been completed.

The biology of the following needle rusts of conifers have been worked out and the results were confirmed by repeating the experiments the second year :—

(c) *Peridermium orientale* (*P. complanatum*) on *Pinus longifolia* with *Coleosporium campanulae* on *Campanula colorata* and *C. canescens*.

(d) *Peridermium brevius* on *Pinus excelsa* with *Coleosporium* nov. sp. on *senecio rufinervis*.

- (e) *Peridermium piceae* on *Picea morinda* with *Chrysomyxa himalayensis* on *Rhododendron arboreum*.
- (f) *Peridermium ephedrae* on *Ephedra vulgaris* with *Hyalopsora* nov. sp. on *Athyrium acrosticoides*.
- (g) *Peridermium abies-pindroina* nov. sp. with *Uredinopsis* nov. sp. on *Polypodium* sp.

The following needle rusts of conifers yet remain to be worked out though more than 300 inoculations were conducted during the last two years in an endeavour to match them:—

- (h) *Peridermium cedri* on *Cedrus deodara*.—Tests in connection with the probable alternate hosts, both broad-leaved and ferns, exceeded two dozen in number. There are still several broad-leaved species which appear likely hosts and on which inoculations will be made this summer.
- (i) *Peridermium thomsoni* on *Picea morinda*.
- (j) *Chrysomyxa deformans* on *Picea morinda*.
- (k) *Chrysomyxa piceae* on *Picea morinda*.

Histological studies on the parasitism of the above 4 species were made and the sequence of their appearance from early spring to autumn recorded.

- (l) *Chrysomyxa dietelli* on *Rhododendron lepidotum*.—Further observations are being continued.

*Routine problems.*—(a) The inoculations on *Dalbergia latifolia* with cultures of a canker fungus have repeatedly failed. Further observations and search for fruit-bodies of the fungus will be made during the rainy season.

(b) *Herbarium.*—A large collection of larger fungi including several species of *Armillaria* and many of *Polyporaceae* has been made. Arrangements were entered into for their naming to build up a well-represented herbarium.

The collection of Himalayan *Uredinales* appears to be almost complete. It consists of a number of new species of *Coleosporiums*, *Phakopsora*, *Uredinopsis*, *Hyalopsora* and several fern rusts which do not appear to have been recorded before.

The collection work will be continued and special notes will be made of the *Agaricaceae* found in the region of *Pinus excelsa* and *Cedrus deodara* for mycorrhizal studies.

A photographic collection of fungi was started for future reference.

## CHAPTER IV.—FOREST ENTOMOLOGY.

## BIOLOGICAL CONTROL.

Several species of parasites of defoliators have been studied with a view to the possibility of their introduction to new localities and to their multiplication under artificial conditions. Of these particular attention has been given to *Cedria paradoxa*, a Braconid which parasitises many species of Pyralid caterpillars, including *Hapalia machaeralis*, one of the two most important teak defoliators and *Margaronia pyloalis*, the mulberry defoliator. This parasite can now be reared in large numbers under laboratory conditions and consignments are being sent to Madras and Burma for the teak defoliator and to the Punjab for the mulberry defoliator. Difficulties arising from the necessity for sending living insects over long distances can be overcome by the use of cold storage; an experimental consignment, consisting of cocoons packed with ice in a vacuum flask, was successfully sent from Dehra to Burma by air.

## CARDAMOM INSECTS.

At the request of the Chief Forest Officer, Coorg, some of the cardamom males in Coorg were inspected during September and October 1936. Numerous types of insect damage were observed but these are not all of universal occurrence. The damage is due to a variety of causes which vary from place to place. There is no evidence of a specific cardamom pest, the insects concerned being derived from neighbouring forest trees. Recommendations were made which should lead to reduction of insect damage.

## SPIKE DISEASE OF SANDAL.

Reports on seasonal incidence and distribution of four more groups of insects have been prepared for the press. In this work 7,700 specimens were identified and 170 species were added to the known insect fauna associated with sandal.

Since 1933 the work initiated by this Institute has been continued by the Madras Forest Department. In September 1936, the Forest Entomologist, at the request of the Chief Conservator, Madras, attended a meeting at Denkanikota to give his opinion on current investigations and to advise in the drawing up of a programme for future work.

The Institute has identified a large number of specimens of the species under observation by the Madras Forest Department.

## LANTANA INSECTS.

The lantana fruit fly, *Ophiomyia lantanae*, is now known to be widespread in India but does not appear to provide the solution for lantana

control ; it has some beneficial effect in making a proportion of the fruits shrivel and therefore unpalatable to birds which normally spread the seed. There is some doubt as to how far attack by the fly affects the viability of the seed and experiments devised to clear up this point are in progress. At present it is not proposed to introduce into India other lantana-attacking insects until results of work in progress in Australia and elsewhere are known ; in the meantime the possibilities of artificial multiplication of certain indigenous species of insects are being investigated.

#### BOREERS OF QUERCUS INCANA.

The Sitoli plantation in West Almora division was visited in June. The oak trees here, which are used for firewood, were found to be attacked by larvae of two large species of Cerambycidae, *Aphrodisium hardwickianum*, the habits of which were previously unknown and *Batocera horsfieldi* which was known to cause serious damage to walnut as well as to oak. A large proportion of the wood content of the tree is lost by repeated attack, the damage now observable being the accumulation of many years' boring. The suggested remedy is to coppice the plantation or at least those trees showing ejection of wood dust, in early spring.

#### GENERAL INSECTARY WORK.

During the year 149 consignments were received from forest divisions in India. 39,000 insects emerged from cages containing attacked material collected by forest officers or by the entomological staff ; most of these insects were identified. In addition, numerous lepidopterous defoliators were reared in connection with biologic studies of these species and their parasites.

#### TRAINING.

A course in forest entomology, consisting of 18 lectures with demonstrations, was given to the Rangers Class by Mr. N. C. Chatterjee, Assistant Entomologist.

Mr. P. N. Chatterjee, a student of Allahabad University, worked in the parasite laboratory of this branch for 2½ months in connection with the preparation of his thesis for the M.Sc. degree.

A sleeper-passing officer of the Indian State Railways was given instruction in elementary entomology with special reference to the detection and classification of damage by borers of sal timber.

#### Systematic Entomology.

The reference collection has been enriched by 702 species, many of which are new to science and have been described in Indian Forest

Records and other scientific publications. As in former years assistance has been given by specialists in various parts of the world but difficulty is still found in obtaining authoritative identification in certain families including some of the parasitic groups so important in biological control.

Considerable headway has been made in the classification of immature stages of Coleoptera and several papers on the subject have been published. Similar work is in progress on lepidopterous larvae of forest importance; the larvae of very few Indian species have been previously described in sufficient detail to enable reasonably accurate identification.

*Tours.*—By Dr. Beeson to Madras in September; to Ranchi in October (Lac Cess Committee); to Lucknow in November (Industries Conference); to Burma in February (in connection with entomological research in Burma). By Mr. Gardner to Simla hills in July; to Mussoorie in September; to New Delhi in November and March. By Mr. N. C. Chatterjee to Madras in September; to Haldwani in December. By Mr. B. M. Bhatia to Almora in June. By Mr. S. N. Chatterjee to Burma in February.

*Museums.*—The chief additions to the entomological museum were 81 examples of damage to timbers by borers. Reptiles were added to the museum of forest zoology.

*Library.*—164 books, besides periodicals, were added to the Zoological Library during the year.

## CHAPTER V.—UTILISATION BRANCH.

## Wood Technology Section.

## 1. RESEARCH.

(a) Work in connection with the preparation of hand lens keys supplemented with low power photomicrographs for the identification of the more important commercial timbers of Assam and Bengal was continued.

(b) Studies on the formation of growth rings in the wood of *Acacia catechu*, *Bombax malabaricum*, *Eugenia jambolana*, *Pinus longifolia*, *Shorea robusta*, *Tectona grandis* and *Terminalia tomentosa* were completed. The results obtained indicated the advisability of studying some more species of certain characteristic anatomical structure. During the period under review, the collection of data was started for *Albizia lebbek*, *Cedrela toona*, *Dalbergia sissoo*, *Michelia champaca* and *Srietenia mahagoni*.

Last year a new type of parenchyma distribution was reported in *Terminalia tomentosa*. During the year further research has been done on this subject with a view to tracing the origin of this distribution. The results so far obtained have been very interesting and the whole problem will be fully discussed in a future paper.

(c) The anatomical study of the woods of Indian Dipterocarps was continued. The macroscopical and microscopical examination of the wood blocks and slides is progressing.

(d) The work on the anatomical study of different varieties of *Terminalia tomentosa* was also continued. This investigation has proved to be very complicated and further research will be necessary before any definite conclusion can be drawn.

(e) Due to lack of material, further study on the relationship between the anatomical structure and the physical properties of *Tectona grandis* was not possible during the period under review. Fresh material (selected according to our suggestion) has now been received and the work will be restarted.

(f) The study on the woods of Indian *Meliaceae* is progressing satisfactorily. More specimens have been cut and mounted during the year.

## 2. IDENTIFICATION OF WOODS.

As usual large numbers of timber specimens were received from various sources. These included a wide range of materials including solid timbers, veneers, plywood, match splints, pencils, etc. The total number of timbers identified during the year was about 350.

### 3. EXAMINATION FOR DETECTING FUNGUS ATTACK.

Many enquirers sent samples of wood suspected of having been attacked by fungus and asked advice as to the suitability of such timbers for certain specific uses. A good many investigations of this type were carried out for the aircraft authorities in India. The number of wood specimens examined in this connection was 66.

### 4. SPECIAL ENQUIRIES.

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for many business firms. Enquiries received under this heading were, as usual, of a very varied nature—each one requiring special technique and manipulation and taking considerable time to complete. The following is an example of an interesting investigation dealt with during the year :—

A firm in Colombo, Ceylon, sent two samples of wood and wanted to know whether they were both teak and if so, the reason for their difference in weight and working qualities. On examination the timbers were both found to be teak. One sample showed normal growth and was of normal weight, while the other showed extremely slow growth. The latter had over 35 rings per inch and the wood mostly consisted of large pores of early wood, leaving very little space for fibres which are usually responsible for strength as well as weight. In this connection, it may be mentioned here that the question of growth rings in relation to the technical properties of wood is being investigated at the Forest Research Institute and it is hoped in time to collect workable data for all important Indian timbers.

### 5. INDEXING PERMANENT SLIDES, ANATOMICAL DATA AND PHOTOMICROGRAPHS.

During the year under review over 600 permanent slides were prepared and added to the authentic collection. These included a large number of species (both Indian and foreign) not previously represented. Anatomical data were also collected from these slides whenever possible and filed for future reference. For publication and exhibition purposes 50 negatives, 400 photomicrographs, 14 enlargements and 8 transparencies were made.

### 6. COLLECTION OF AUTHENTIC WOOD SPECIMENS.

(a) *From India.*—A fairly large number of authentic wood specimens backed by herbarium material were received from the different provinces for the Institute's standard collection.

(b) *From abroad*.—During the year altogether 129 wood specimens were added to the foreign collection. These were received from England, Nigeria, the Philippine Islands, and the United States of America. To the donors our sincere thanks are due for helping the Forest Research Institute to make its collection of commercial timbers of the world as complete as possible.

#### 7. DISTRIBUTION OF WOOD SPECIMENS.

In response to requests from abroad and various parts of India, 898 samples of timber were supplied to interested enquirers.

#### 8. GENERAL.

A short course in Wood Technology was given to Mr. A. Ghaffar, Student Sleeper Passing Officer, B. N. Railway, Calcutta. Mr. Jagdish Prasad, Assistant Engineer, United Provinces, was also under training in the Section for a short time with a view to obtaining some knowledge of wood anatomy from the point of view of an engineer.

#### Timber Testing Section.

##### SPECIAL INVESTIGATIONS.

1. The study of the effect of corrosive chemicals on wood (*vide* para 9 page, 44), was continued during the year under review. Small sticks of teak (*Tectona grandis*), deodar (*Cedrus deodara*), chir (*Pinus longifolia*), kail (*Pinus excelsa*), sissoo (*Dalbergia sissoo*), and sal (*Shorea robusta*) were immersed in different strengths of sulphuric acid and caustic soda, with controls in water, for different periods. The preliminary tests have been finished and these show a very large reduction in the compressive strength of the timbers as the result of soaking in higher concentrations of caustic soda. The strength of the pieces soaked in sulphuric acid, however, did not show much reduction. The investigation is being continued.

2. Yon (*Anogeissus acuminata*) was suggested by the Forest Research Institute as a possible substitute for ash for making skis. This enquiry was received from the Timber Adviser to the High Commissioner for India in London. The suggestion of a possible substitute created much interest among the manufacturers of skis in England and the Timber Adviser has requested the Burma Forest Department to supply some timber for trial. The results of this trial will be awaited with interest.

3. An enquiry was received from the Linen Industry Research Association, North Ireland, through the High Commissioner for India, London, for a suitable substitute for boxwood (*Buxus sempervirens*) for making spinning rollers. All the boxwood now used is imported

into England from Persia, Arabia and Africa and it sells at a very high price. The hoxwood available in India is at present unfortunately insufficient even for the internal demand. The following species, namely chooi (*Sageraea elliptica*), kow (*Olea ferruginea*), parrotia (*Parrotia jacquemontiana*), *Gardenia latifolia*, *Gardenia lucida* and *Murraya exotica* were suggested for trial and specimens were sent to the Director for his opinion. This investigation if successful may open up a market for one or more of the above species. Good prices would be paid for a suitable wood.

4. Wood used in aircraft construction and samples obtained from wooden parts damaged in accidents were tested from time to time for the Director of Civil Aviation.

5. Fifteen consignments of glue joints submitted by Ground Engineers of the different Flying Clubs of India for their licence examination were examined and reported on to the Director of Civil Aviation. The Officer in Charge of the Timber Testing Section designed an improved type of end grip for holding efficiently these test specimens in the testing machine. The improved grip is constructed so as to eliminate all bending stresses on the joint and to apply a direct pull in the plane of the joint.

6. A special investigation has been started with a view to introducing Indian timbers into aircraft construction. Practically all aeroplane spruce is now obtained from Canada or the United States of America. Indian spruce and fir, *Michelia excelsa*, *Polyalthia fragrans* and *Phoebe* spp., are under investigation for this purpose. The Officer in Charge, Timber Testing Section, discussed the requirements of timber used in aeroplanes with the Director of Civil Aviation and explained, with the aid of small specimens, the strength data of the above species. He also visited with the Inspector of Aircraft, the civil aerodrome at Delhi where considerable repair work was going on. There he found that actually about 75 per cent. of the spruce used was under 10 ft. in length. As the only spruce available in India is in sleeper form and as these sleepers are usually 10 to 12 ft. long, it has been explained to the aircraft authorities that Indian spruce might be used for 75 per cent. of the aircraft wood work as it is equally as strong as Canadian spruce. As, however, it is necessary to satisfy the designers and manufacturers in England about the suitability of Indian spruce before it can be introduced into the specifications, steps are being taken to send samples to the manufacturers through the Director of Civil Aviation for test. Very high prices are paid for aircraft spruce, and this investigation might eventually provide a profitable market for selected Punjab spruce.

7. In order to see whether any improvements were required in the grading rules for teak squares, some discussions were held with the Forest Economist, Burma, at the time of his visit to the Forest Research

Institute. It was decided that the Officer in Charge, Timber Testing Section, should re-examine in India some consignments of teak passed in Burma under the new rules. A thorough examination of 2,000 tons of Burma teak now arriving at the North Western Railway workshops at Lahore is in hand.

8. Great efforts were made during the year to popularise Indian timbers and to increase their utilisation. The Timber Testing Section's share in this work was the preparation of strength charts and tool handle posters, both of which proved very popular. The first issue was sold out in a short time.

9. The testing of poles of different Indian species was started during the year as a result of numerous enquiries received on this subject. Treated wooden poles are now being used for telegraph, telephone and power lines, and reliable strength data are necessary for preparing specifications for different requirements. The investigation will be continued.

10. At the Utilization Conference in March 1937, the Officer in Charge discussed the relation of rate of growth to strength. He also explained the relative merits of sapwood and heartwood from the strength point of view.

#### ROUTINE TESTING.

During the year under report tests were continued under Project 1 (Standard tests on small clear specimens) and Project 2 (Standard test on structural timbers). Other routine testing such as glue adhesion, plywood, hammer handles, etc., was also done whenever enquiries were received.

#### NUMBER OF SPECIES TESTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1 . . .	15	7	7	..
Project No. 2 . . .	1	7	..	..
Project No. 0 . . .	Under all heads . . .			67

The 67 consignments under Project 0, include 15 consignments of glue joints submitted by Ground Engineers for their licence examination.

#### NUMBER OF SPECIES COMPUTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1 . . .	15	4	9	..
Project No. 2 . . .	..	3	..	..
Project No. 0 . . .	Under all heads . . .			64

## List of species tested under Project No. 1 during the year.

Species.	From	Condition.
<i>Amoora rohituka</i> (amoora)	Nowgong Div. (Assam)	Air dry.
<i>Amoora wallichii</i> (amoora)	Katha Div. (Burma)	Kiln dry.
<i>Artocarpus integrifolia</i> (koa)	South Western Div., Colombo (Ceylon).	Green.
<i>Bassia butyracea</i> (hill mohwa)	South Andaman	Green and Kiln dry.
<i>Cinnamomum iners</i> (cinnamon wood).	Tavoy Div. (Burma)	Air dry.
<i>Engelhardtia spicata</i> (moglaipoma)	Cachar Div. (Assam)	Green.
<i>Eucalyptus eugenioides</i>	Nilgiri Div. (Madras)	Air dry.
<i>Eugenia</i> spp. (jaman)	Cachar Div. (Assam)	Green.
<i>Heterophragma roxburghii</i>	Nagpur Div. (C. P.)	Green.
<i>Kaya floribunda</i> (karal)	Cachar Div. (Assam)	Air dry.
<i>Mimusops littoralis</i> (bullet wood)	South Andaman	Green and Kiln dry.
<i>Myristica</i> spp. (malaboda)	South Western Div. Colombo, (Ceylon).	Green.
<i>Pentace griffithii</i> (thitalse)	Lakhimpur Div. (Assam)	Green and Kiln dry.
<i>Poeciloneuron indicum</i>	N. Mangalore Div. (Madras)	Green.
<i>Pongamia glabra</i> (sakkaranji)	E. D. Kanara (Bombay)	Green and Kiln dry.
<i>Pterocarpus santalinus</i> (red sanders)	S. Cuddapah Div. (Madras)	Green.
<i>Saccolatum tomentosum</i>	E. D. Kanara (Bombay)	Green and Kiln dry.
<i>Shorea robusta</i> (sal)	Kurseong Div. (Bengal)	Air dry.
<i>Stereospermum chelonoides</i> (padri wood).	S. Mangalore Div. (Madras)	Green.
<i>Tectona grandis</i> (teak)	Kurseong Div. (Bengal)	Air dry.
<i>Terminalia myriocarpa</i> (hollock)	Lakhimpur Div. (Assam)	Green and Kiln dry.

## List of species tested under Project No. 2.

Species.	From	Condition.
<i>Amoora wallichii</i> (amoora)	Kurseong Div. (Bengal)	Air dry.
<i>Artocarpus chaplasha</i> (chaplash)	Lakhimpur Div. (Assam)	Air dry.
<i>Chukrasia tabularis</i> (chickrassy)	Kurseong Div. (Bengal)	Air dry.
<i>Dipterocarpus griffithii</i> (gurjun)	Burma	Air dry.
<i>Duabanga sonneratioides</i> (lampati)	Kurseong Div. (Bengal)	Air dry.
<i>Terminalia arjuna</i> (arjun)	Saranda Div. (Bihar and Orissa)	Air dry.
<i>Terminalia myriocarpa</i> (hollock)	Assam	Green.
<i>Terminalia paniculata</i> (kindal)	E. Kanara Div. (Bombay)	Air dry.

About 14,000 mechanical tests and 19,000 physical determinations were made during the year. In addition to computing the routine tests, the computing office prepared a large number of tables for answering enquiries. Numerous computations for the grading of teak squares were also made. These included calculations for about 40,000 c.ft. of timber. This work was done in consultation with the Forest Economist, Burma.

## Wood Seasoning Section.

### 1. KILN DRYING RESEARCH WORK.

In order to study the drying of refractory hardwoods, which dry at a very slow rate, and in which the process of drying is considerably affected by the leakage of moisture through the walls of the kiln, a laboratory kiln was designed and fitted with a metal lining in the interior. The construction of the kiln was completed just after the close of the year under review, and it is hoped to be able to report some progress in this direction next year.

The supply of timber for kiln drying experiments is limited, and such timbers as were available were all reserved either for the furnace kiln, or for the new metal-lined kiln, the construction of which was much delayed by the work which had to be done for the Lucknow exhibition. Only seven charges of timber were dried in the large internal fan kilns, and none of these was actually meant for the kiln drying project. Five out of the seven charges were of *Dalbergia sissoo*, and it is satisfactory to report that in all cases, this timber was dried from a green condition to about 8 per cent. moisture content in ten to twelve days.

In the small laboratory kilns, twelve charges were dried during the year, mostly for the Timber Testing Section. A large number of woods now being tested by the Timber Testing Section are of a highly refractory nature, and their drying offers many difficulties. Nevertheless, as each species and consignment is dried separately in a small kiln, some very useful information is being collected on the drying of some of our more refractory hardwoods.

### 2. FURNACE KILN.

This kiln has given very satisfactory results throughout the year. In all, 13 charges have been dried so far, out of which 6 were dried during this year. A detailed report of the results obtained up to the end of 1935, was published as Indian Forest Record, Utilization, Vol. 1, No. 3. The following short notes on the woods dried during the year are of interest :—

1. *Dalbergia sissoo*.—Two charges of this wood were dried in the form of one-inch planks. The initial moisture content in one case was 46 per cent. and this was reduced to 8 per cent. in 7 days' drying. Apart from some trifling cracking around knots, and some very slight warping and cupping, there was no appreciable degrade.

2. *Artocarpus chaplasha*, *Palaquium ellipticum*, and *Terminalia bialata* were dried in a mixed charge in the form of one-inch planks. The *Artocarpus chaplasha* contained 35 per cent. moisture, and in 4 days it was dried down to 8 per cent. There was no noticeable degrade of any kind.

3. A charge of *Albizia procera* one-inch planks was dried from the green condition, containing over 100 per cent. moisture, in 18 days. The rate of drying of samples was fairly rapid in the beginning, about 13 per cent. in a day, but the rate became slower near the end of the drying process. The timber had some original heart shakes, and it was found that the shakes had opened out during the drying and some collapse and warping was caused by the presence of these shakes. About half the planks showed no degrade of any kind, but on the whole the appearance of the dried material was not very attractive. This was probably because the conditions of drying were too severe in the early stages. A small quantity of this wood, from the same lot and in 1½ inch planks, was included in a subsequent charge (described below) and finished up in a much better condition.

4. A mixed charge of thick timbers, consisting of *Acacia arabica*, *Adina cordifolia*, *Albizia procera*, *Artocarpus hirsuta*, and many other species in small lots, was dried with very satisfactory results. Except for *Albizia procera* which was in 1½" planks, all the species were in the form of 2-inch planks, and were in a green condition to start with. The drying process was completed in 24 days, and it is highly gratifying to note that except for surface discolouration, no appreciable degrade of any kind was noticeable. No increase in end splits and surface cracking was found at the end of drying, the only defect being a little warping in some very wide *Acacia arabica* planks (width up to 32"), a few split knots in the *Adina cordifolia*, and some slight spring in some planks of *Artocarpus hirsuta*. On the whole, the condition of the timber after drying was very good, and the time taken for the drying was certainly less than that required for the same material in an ordinary steam-heated kiln.

### 3. AIR-SEASONING.

Small quantities of material left over from Project VII experiments were stacked for air-seasoning as usual, and the observations on thick scantlings of eight species, started in the previous year, were continued. An experiment on the seasoning of some refractory hardwoods in the form of logs and half-logs (a log sawn into 2 portions through the heart centre) was completed, and it was noticed that the timber from logs and half-logs seasoned for about a year prior to conversion was in much better condition at the end of the air-seasoning period than the timber obtained direct from green conversion. This was particularly noticeable in the case of *Quercus lamellosa* and *Q. lineata*, from which green conversion into plank material yields no useful timber at all. This method of seasoning may be useful in the case of certain hard and very refractory woods, and it is proposed to investigate the relative merits of green conversion and log seasoning in further detail.

#### 4. WATER-SOAKING PRIOR TO AIR-SEASONING.

The tests on end-matched specimens of various species, seasoned with and without previous soaking in water, are being continued. Some of the specimens are to be left under water for a period of 7 years in order to see the effect of such long soaking. Results so far do not indicate any material difference in the shrinkage and hygroscopicity of wood with and without water-soaking.

#### 5. AIR-SEASONING OF RAILWAY SLEEPERS.

A tour was undertaken by the Officer in Charge, Seasoning Section, to some exploitation areas in the East Almora division of the United Provinces, in order to make a preliminary investigation on the seasoning of chir sleepers from the Kumaon forests. As a result of this tour, a scheme was drawn up for a detailed study of the seasoning of chir sleepers from the stump to the railway track. The experiment will be started during next working season, in co-operation with the United Provinces Forest Department, the Indian Turpentine & Rosin Co., Ltd. (the sleeper contractors) and the Sleeper Control Officer of the Northern Group. All the authorities concerned have expressed their willingness to co-operate. In addition to the effect of various methods of stacking and of the use of end-paints, for which purpose coal tar and chir tar will be tried, the effect of seasoning in the form of logs will be studied. It has been noticed that sleepers obtained from logs left in the forest for about 9 months showed less cracking than those obtained from logs cut up soon after felling, although the difference in the moisture content of freshly felled and seasoned logs was not very appreciable. Possibly seasoning in log form results in some equalisation of stresses in the wood and the point is, therefore, worth investigating.

An investigation on the seasoning of sal sleepers has also been taken in hand and some preliminary investigations were carried out at Kalyan (Great Indian Peninsula Railway) and at some of the sal sleeper depots along the Rohilkund and Kumaon Railway. An experiment to determine the "life" of seasoned and unseasoned sal sleepers has been started in co-operation with the Rohilkund and Kumaon Railway at Lucknow. One thousand metre gauge sleepers were selected for this purpose. Half of these will be laid in the track immediately and the other half after one year's seasoning. The condition of these sleepers will be examined from time to time. The difference, if any, between the average life of the two lots will indicate if there is any benefit in seasoning sal sleepers prior to laying them in the track. At present there is no information on this subject.

The results of the preliminary investigation on the seasoning of sal sleepers were briefly :—

- (i) that sal sleepers in the United Provinces are usually brought to the depots and put up for passing soon after they are cut ;
- (ii) that the sleepers at the time they are taken over by the railways are very green, containing 60 per cent. to 80 per cent. moisture ;
- (iii) that one year's seasoning in close-crib stacks under mild climatic conditions is not sufficient to season them ;
- (iv) that the presence of sapwood in these sal sleepers is responsible for a large percentage of rejections of sleepers from the United Provinces forests. In this respect, the use of treated sapwood sleepers would be a great help, and the matter is now being investigated at the Forest Research Institute. The United Provinces Forest Department has already supplied sapwood sal sleepers for the investigation.

#### 6. ELECTRIC MOISTURE METERS.

In response to a circular letter sent to various government and state departments, and wood working firms, orders were received for 12 meters, and arrangements were made for their manufacture locally. The cost of a meter came to Rs. 175. More enquiries are being received, and it is expected that the demand for these meters will increase with a spread of knowledge about the seasoning of wood.

Further experiments are in hand to increase the range and usefulness of the meter.

#### 7. A SURVEY OF THE MOISTURE CONTENT OF WOOD.

This investigation was inaugurated last year and was continued during the year under report. The data received from various centres are being worked up and analysed as they come in.

#### 8. SHRINKAGE STUDIES.

A large number of shrinkage specimens were kept under observation during the year. Detailed studies are being made of the shrinkage of wood from the green to the air dry condition, as well as the changes in the dimensions of seasoned wood due to fluctuations in atmospheric humidity.

During the year a few experiments on the longitudinal shrinkage of wood were started. The investigation on the effect of impregnation with various chemical substances on the subsequent shrinkage and

swelling of wood was continued. Furfuryl alcohol was tested for impregnating wood and thereafter resinifying the alcohol in the wood by means of dilute acids. Another synthetic resin imported from the United States of America is also being investigated. The results so far do not show more than 30 per cent. to 40 per cent. reduction in the shrinkage and swelling of wood with changes in atmospheric humidity.

#### 9. ACTION OF CHEMICALS ON WOOD.

Experiments to determine the action of various common acids, alkalis, and other chemicals, on Indian woods were started with a view to finding out the suitability of our indigenous timbers for the manufacture of apparatus and machinery for the chemical industry. Such articles comprise filter presses, reaction and crystallization vessels, fermentation and storage vats, etc.

Experiments on the effect of different concentrations of sulphuric acid and caustic soda on the following woods were finished during the year :—

- (i) *Cedrus deodara* (deodar).
- (ii) *Pinus excelsa* (kail).
- (iii) *Pinus longifolia* (chir).
- (iv) *Tectona grandis* (teak).
- (v) *Shorea robusta* (sal).

The effect of soaking the wood for definite periods on the strength of wood was investigated by means of compression parallel to grain and the R. A. F. impact tests. It was found that in compression parallel to grain, the acid did not cause any appreciable weakening of the wood, while the alkali reduced the strength considerably. The R. A. F. impact test, on the other hand, gave very erratic results, the alkali treated wood in some cases being found to be tougher than the water-soaked controls. This point is being further investigated, and during the coming year it is proposed to carry out some static bending tests as well.

#### 10. LUCKNOW EXHIBITION.

A model of the Furnace kiln was prepared and a number of posters were drawn for the Industrial and Agricultural Exhibition held in Lucknow during last winter. A poster illustrating the method of stacking timber for air-seasoning was also printed (in English). This poster was distributed by the Forest Research Institute and translations of it in Urdu and Hindi were later printed and distributed by the Forest Department of the United Provinces.

## 11. ENQUIRIES.

Drawings showing the detailed construction of the furnace kiln were supplied to more than 10 enquirers, and details about the erection of small steam-heated kilns were also sent to 7 other enquirers who asked for them. The number of important seasoning enquiries dealt with during the year was 56, which shows an increasing interest in the seasoning of wood.

### Wood Preservation Section.

#### INCORPORATION OF A FIREPROOFING MEDIUM WITH ASCU WOOD PRESERVATIVE.

Considerable experimental work was done in this connection and the best results were obtained by employing boric acid with Ascu. Although in most ways the combination appeared to be satisfactory, the fire retarding efficiency of the combination still requires to be improved.

#### INCORPORATION OF DYES WITH ASCU WOOD PRESERVATIVE.

Ascu, *per se*, does not give any very distinctive colour to some woods treated with it, especially when it is used in low concentrations with brown and other coloured timbers. This lack of colouration is important, as inspecting officers frequently cannot tell whether timber has been treated or not. Attempts were therefore made to mix a dye with Ascu solution. Although several dyes of different kinds and colour were tried, it was found that only "Acid fuchsin" remained stable for any number of days when combined with Ascu. The colour obtained, however, was not very pleasant. It will be necessary to make further experiments on this subject so that, if possible, a pleasant green colour can be obtained.

#### PRESERVATION AND WATERPROOFING TESTS ON JUTE CANVAS.

Test samples were prepared by treating them with various combinations of Ascu, hide glue and petroleum asphalt. This work was undertaken for the Imperial Council of Agricultural Research. Some of the samples so treated have been submitted to a durability test against termites along with untreated controls, as well as with pieces treated with rubber latex sent for test by Messrs. The Cuprinol Co., Ltd.

#### HARDENING OF TIMBER.

A few preliminary experiments were made with the object of trying to form putty in wood by impregnating small pieces of timber with a

solution of calcium chloride and sodium carbonate, followed by a linseed oil treatment. As such treatment helps to make wood more moisture resistant also, it would appear that further work in this direction might lead to some useful results.

#### GRAVEYARD TESTS.

(a) Samples of the following proprietary boards or preservatives sent by different firms were submitted during the year under review to test in the "graveyard" :—

Garostone.

Beaver board.

Sundeala board (new brand).

Presotim.

Drymol.

Osmose-treated eucalyptus and pine sections.

Woodguard.

Celotex board.

Cuprinol-treated veneers.

(b) Untreated specimens of the following species were laid down in the test yard :—

*Heterophragma roxburghii*.

*Pongamia glabra*.

*Saccopetalum tomentosum*.

*Cassia fistula*.

#### WORK IN THE WOOD PRESERVATION PLANT.

A new Ascu pressure wood preservation plant, of which the treatment cylinder is in two sections of 20 ft. length each and with a diameter of 14", was installed during the year. This new cylinder makes it possible for poles and timber up to 40 ft. in length to be treated under pressure with Ascu. Formerly we have not been able to treat such long timbers.

The wood preservation plant was kept very busy during the year treating large quantities of timber for Timber Development, research, and demonstration work, and for fence posts and other requirements of the New Forest estate.

# DEMONSTRATION TO THE NORTH WESTERN RAILWAY ON RELATIVE PENETRATION OF ASCU AND COAL TAR CREOSOTE INTO CHIR SLEEPERS.

During the first week of September 1936, Messrs. A. E. Greene, Sleeper Control Officer, N. W. Railway, and H. M. Glover, Conservator of Forests, Eastern Circle, Punjab, visited the Forest Research Institute to witness some comparative tests on the relative penetration of cold Ascu and hot creosote into the heartwood of chir broad-gauge sleepers. One set of halves of 30 chir B. G. sleepers (brought to Dehra Dun from Dhilwan) were treated with Ascu under pressure and the remaining halves of the same sleepers were treated with a hot mixture of creosote and crude oil. The sleeper halves were later cut at mid-length to observe the penetration of the preservatives in the heartwood.

In the words of Mr. F. Canning, C.I.E., I.F.S., Officiating Inspector General of Forests at the time, the results of the demonstration may be stated as follows :—

“The general conclusion regarding the results was that in this batch of sleepers the penetration of sapwood was complete in the case of Ascu and practically complete in the case of creosote. The density of the Ascu preservative in the sapwood was generally markedly greater in the sapwood than in the heartwood. In the creosoted sleepers, penetration in the sapwood was also generally complete, but the density of the creosote in the sapwood did not appear so markedly greater than in heartwood. In a few places in the sapwood probably, it is understood, where there was sap stain, a fungal attack considered not very injurious — the creosote penetration was poor. In the heartwood the penetration both by Ascu and by creosote was erratic and irregular; in the irregularity of the penetration of the preservatives there was generally more or less correspondence between the penetration of Ascu and of creosote.”

“The general conclusion was that, while every reservation must be placed against drawing unwarranted assumptions from a single and limited experiment of this nature, it was agreed that in this case penetration of both Ascu and creosote in the heartwood of chir was erratic and that there was certainly nothing in favour of Ascu as regards its penetration as compared with creosote but on the other hand the penetration of creosote was probably slightly better than that of the Ascu.”

“It may be noted that in two previous experiments of this nature the results were slightly in favour of Ascu as compared with creosote. So far as the evidence before me exists at the present moment I should be inclined to say that if penetration obtained with creosote is considered satisfactory, the penetration of Ascu should be equally satisfactory.

Mr. Glover considered that the penetration which we obtained in this experiment was distinctly better than that which he had observed in the sleepers treated by the Company at Dhilwan."

A report on the whole investigation was later printed (for departmental use only).

### Wood Workshop Section.

This section continued to function on a reduced scale as a supply unit for other sections, while the Officer in Charge devoted the greater part of his time to veneer and plywood research and to glue testing. A great deal of the above officer's time was taken up in organising and preparing exhibits for the Lucknow Exhibition.

The Timber Testing Section was supplied with 14,443 wood specimens for test purposes as detailed below :—

#### Static bending—

Research 1R . . . . .	287
Regular 1 . . . . .	1,275
Vehicle minor=VM . . . . .	689
Plywood 1PW . . . . .	26

#### Impact bending—

Special 2 Spl. . . . .	4
Regular 2 . . . . .	744
Royal Aircraft 2RA . . . . .	2,023

#### Compression parallel—

Structural 3Str. . . . .	156
Regular 3 . . . . .	2,369

#### Compression perpendicular—

Structural 4Str. . . . .	75
Regular 4 . . . . .	762
Special 4Spl. . . . .	30

Hardness—5 . . . . .	657
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#### Shearing—

Regular 6 . . . . .	2,626
Plywood 6PW . . . . .	142
Glue joints 6JB . . . . .	45

Tension perpendicular to grain—7 . . . . .	762
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Torsion—8 . . . . .	475
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Shrinkage radial and tangential—9 . . . . .	652
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Shrinkage volumetric—10 . . . . .	368
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#### Hammer handles—

1H . . . . .	5
2H . . . . .	6
Aircraft—1A . . . . .	265

The Wood Technology Section was supplied with 8 "Gamble" specimens and 685 hand specimens,

In addition to supplying other sections with converted material for research purposes this Section completed 372 jobs of a varied character including the making of :—

Handles (various).

Packing cases (various).

Tables and exhibition furniture.

Demonstration bridges (for Lucknow Exhibition).

Exhibition boards (various).

Trays (for Lucknow Exhibition).

An earthquake-proof house (for Lucknow Exhibition).

Lamp stands.

Model seasoning kilns.

Frames (various).

Boxes (various).

Stands for exhibits.

Switch boards.

Models of houses.

Rollers.

Models of furniture.

Experimental floors.

Ladders.

Veneer and plywood panels.

247 logs, 355 sleepers, 60 bolts and 58 poles of various species were converted in the sawmill during the year. The logs and bolts were converted mainly for the Timber Testing, Wood Seasoning, and Wood-working Sections.

In addition to the above, much miscellaneous work was done, such as the preparation of crossers for stacking timbers, the cutting of planks and scantlings for use in other sections, and the cutting of firewood from off-cuts for the furnace kiln.

Reports on the working qualities of specimens of the undermentioned timbers were recorded during the period under review :—

*Podocarpus wallichianus.*

*Pterocarpus santalinus.*

*Bombax malabaricum.*

*Eucalyptus eugenioides.*

*Amoora wallichii.*

*Terminalia citrina.*

*Tectona grandis.*

#### ENQUIRIES.

Various enquiries in connection with woodworking and related subjects (other than veneers, plywood and glues) were received and dealt with.

#### TESTS.

Project VIII. Tests were carried out on the undermentioned species and the results were sent to the Forest Utilization Officer, Bengal:—

*Cryptomeria japonica.*

*Bucklandia populnea.*

Several sets of tests on gluing leatherette on portable gramophones were carried out (using a casein cement of our own formula) for The Gramophone Co., Ltd., Dum Dum, Calcutta, and the results with suggestions, advice and samples were sent to the firm.

Tests were carried out on shellac hounded 3-plywood of hollock for the Director of the Indian Lac Research Institute, Bihar, and the results were reported.

Project VIII tests were carried out on various logs of hollong (*Dipterocarpus macrocarpus*) sent by the Deputy Conservator of Forests, Lakhimpur, Assam, and the results (with samples of the veneers) were reported.

Project VIII tests were also carried out on a log of *Boswellia serrata* for the Dewan of Korea State and the results were reported to him.

#### TRAINING.

A course of training in plywood manufacture was given to Mr. Manmohan Lal, B.A., a representative of Messrs. The Krishna Roller Flour Mills, Ludhiana. The firm acknowledged their appreciation of the tuition given and wrote "We feel highly grateful to you for your taking a great interest in giving training to Mr. Manmohan Lal our representative who was sent to you for taking training in the manufacture of plywood. We hope his training will be very useful to us for starting a small plant here."

Courses of training in saw-doctoring were also given to selected soldiers from the K. G. O. Bengal Sappers and Miners, Roorkee. This unit now sends their men here regularly for courses in saw-doctoring.

The Commandant of the corps has expressed his thanks for our co-operation in this matter and has stated that the training given is of great value to them.

## VENEER SUB-SECTION.

Logs of the following species were peeled for routine tests under Project VIII :--

- Boswellia serrata.*
- Terminalia tomentosa.*
- Castanopsis hystrix.*
- Anthocephalus indicus.*
- Michelia champaca.*
- Artocarpus chaplasha.*
- Lagerstroemia flos-reginae.*
- Millettia pendula.*
- Abies pindrow.*
- Gmelina arborea.*
- Pterocarpus macrocarpus.*
- Dipterocarpus turbinatus.*

Many enquiries relating to veneers, plywood and glues were received and dealt with during the year.

## TOURS.

The Officer in Charge went to Calcutta and Delhi in the cold weather in order to see what markets exist for veneers of Indian timbers. He took with him samples of veneers and discussed their possibilities with architects, ship-builders, cabinet makers, and interior decorators, etc. The tour resulted in one firm in Calcutta giving a definite assurance that they intended to start operating at the end of this year, so it is hoped that before long a supply of Indian wood veneers will be available for those requiring them.

## MISCELLANEOUS.

Mr. A. Gaffar, Student Sleeper Passing Officer, underwent a course of study in the Section in August 1936.

Mr. Ghulam Nabi, Headmaster, Government Wood Working Institute, Jullundur, also underwent a course of study in the Section in August 1936.

At the request of the Engineer-in-Chief, Army Headquarters, Simla, the Officer in Charge of Woodworking, accompanied by the Forest Economist, paid a visit to the K. G. O. Bengal Sappers and Miners Workshops at Roorkee to inspect the Army folding hoat and pontoon equipment and to offer suggestions and advice for their improvement.

The Engineer-in-Chief, Army Headquarters, Simla, apparently appreciated the help given. He wrote as follows:—"I wish to convey my thanks to the Forest Economist, to Mr. Nagle, and all members of the Institute, for the trouble they have taken in compiling these most useful reports".

### Minor Forest Products Section.

#### F. R. I. PORTABLE CHARCOAL KILN ("FRIKILN").

The number of enquiries about this kiln increased still further as the result of the publicity given to it at the Lucknow Exhibition, and as the result of a recent poster. The stock of reprints containing a note on the kiln was speedily exhausted. Twenty kilns are now working in various parts of India.

#### 2. CHARCOAL BRIQUETTING.

A note embodying the results of the experiments on charcoal briquetting with different binders was published in the *Indian Forester* of February 1937. It describes the various binders such as cereals, *Bauhinia retusa* gum, tamarind (*Tamarindus indica*) seeds, etc., tried for briquetting charcoal intended for domestic use. The cereals and tamarind seeds are ground into a powder and then boiled in water to form a paste before they are mixed with the charcoal in the grinding mill. Rice (5 per cent.) and tamarind seeds (6 per cent.) gave the strongest briquettes. The cost of briquetting using these binders worked out at Re. 0-3-11 and Re. 0-2-11 respectively per Bengal maund, and they offer therefore commercial possibilities.

#### 3. CULTIVATION OF MEDICINAL PLANTS.

It was mentioned in last year's report that (1) *Datura fastuosa*, (2) *Artemisia maritima* (Kashmir variety), (3) *Solanum indicum*, (4) *Hydrocotyle asiatica*, (5) *Plantago psyllium*, (6) *Mentha piperata* and (7) *Carum copticum* were grown successfully in the minor forest products garden. The cultivation of these plants was continued to confirm the previous year's results.

The cultivation of pyrethrum (*Chrysanthemum cinerariaefolium*) was also continued. The plants grown from seeds received from Japan and Belgrade were vigorous and healthy and began flowering in May. The flowering period, however, was very short due to the early and heavy monsoon which caused much mortality among the plants. By the end of the monsoon every one of the plants had been killed. Plants were again raised from seeds from plants which had been grown in the minor forest products garden during the previous year. The germina-

tion of these seeds was peculiar in that it continued over a period of two months, a few seeds germinating almost every day during the period. The new seedlings have been transplanted, some to open beds and some to pots. They were healthy at the end of the year under report.

The cultivation of *Derris elliptica* and *D. malaccensis* was continued, but the rate of growth was very low and the root system was poor. These plants cannot apparently be grown on a commercial scale in a climate like Dehra Dun. Some cuttings of the above two species of *Derris* were received towards the end of December from the Malayan Agricultural Department through the courtesy of the Imperial Council of Agricultural Research. The end of December is about the worst time for planting tropical cuttings in Dehra Dun on account of heavy frost, and the cuttings failed to strike root in spite of various devices improvised to keep them warm.

*Datura stramonium* was tried, but became sickly during the summer and the plants died one by one, apparently unable to stand the dry heat.

Arrangements were made with the Forest Botanist to obtain seeds of medicinal plants from various botanical gardens and universities, etc., in Europe, America, and China, by exchange, and several packets of seeds were received towards the close of the year. Our thanks are due to the Forest Botanist for his co-operation in the matter.

#### 4. MATCH WOODS.

A list of Indian woods tried for match manufacture was published during the year. Anyone interested can obtain a copy by applying to the Utilization Officer, New Forest P. O., Dehra Dun.

#### 5. COLLECTION OF INFORMATION ON DRUGS OF FOREST IMPORTANCE.

This work, which is being carried out in conjunction with the Biochemist and the Forest Botanist, was finished during the year, except for the addition of some further information collected recently.

#### 6. OUTTURN OF MINOR FOREST PRODUCTS (DRUGS).

It was mentioned in last year's report that a circular had been sent to all forest officers in India asking for information on the minor forest products within their jurisdiction. Replies have been received from all provinces and from many States, and the information is now being tabulated and recorded. Our thanks are due to all those who responded, for their co-operation in the matter.

## 7. SUBSTITUTE FOR CORK FOR USE AS INSULATORS IN REFRIGERATORS.

This enquiry was not continued during the year as the production of extremely fine glass wool by a patented process recently discovered in Germany makes any other material uneconomical for the purpose in view.

## 8. ENQUIRIES.

Over 400 enquiries dealing with the supply, collection, marketing, prices, etc., of minor forest products were dealt with during the year.

## Paper Pulp Section.

### I. EXPERIMENTAL FACTORY.

1. *Disintegration of bamboos.*—The newly designed feeding equipment to the disintegrator did not give improved results as regards the flattening and partial crushing of bamboo stems. It was consequently decided to have a suitable equipment designed and made by an outside engineering firm. Negotiations in this connection are in progress with Messrs. The Kumardhubi Engineering Works, Ltd., Kumardhubi (Bengal).

2. Semi-commercial tests on *Bambusa tulda* (*mitenga*), *Dendrocalamus longispathus* (*orah*) and *Teinostachyum dullooa* (*dolu*) were carried out and completed. The factory experiments confirmed the laboratory results as regards the suitability of the above species for pulp and paper making. Factory trials were also carried out on the production of pulp and paper from a mixed lot of the following five species from Bengal :—

- (1) *Oxytenanthera auriculata* (*kaliserri*).
- (2) *Dendrocalamus hamiltonii* (*kokwa*).
- (3) *Dendrocalamus longispathus* (*orah*).
- (4) *Bambusa tulda* (*mitenga*).
- (5) *Teinostachyum dullooa* (*dolu*).

Equal quantities of each of the five species were taken, and the digestion, bleaching, etc., were carried out under normal routine conditions. The yields of pulp and paper and the quality of paper produced were about the same as those for the individual species, thus showing that mixed species of bamboos could be used for the manufacture of pulp or paper on a large scale.

3. Pulp and paper making tests were carried out on *Anthistiria gigantea* (*ulla grass*) from Kheri division, U. P. The grass gave poorer results than those obtained in 1934 from a consignment of the same

grass from the same division. Not only were the yields of pulp and paper appreciably less, but both pulp and paper showed shives, in spite of the more drastic bleaching treatment employed. On enquiry it turned out that the first lot (1934) was cut from a fire-protected area and the second lot (1936) from an area subjected to annual burning. This factor might have had an influence on the quality of the two lots. There are other factors, however, which might also have influenced the quality. They are (1) the different times of the year at which the two lots were cut, (2) the different ages of the two lots, and (3) the quality of the soil and drainage of the ground on which the two lots were growing. In order to find out exactly which factors are likely to influence the quality of grass for paper-making, it is proposed to obtain small samples of the grass from different areas, cut at different times of the year, and to test them in the laboratory for yield of cellulose and consumption of chemicals. The Conservator of Forests, Eastern Circle, U. P., has already made arrangements for the supply of the different samples.

4. Paper-making trials were carried out on *Saccharum munja* (*munj* grass) sent by the Radbasoami Satsang Sahha, Dayalbagh, Agra. The quality of the paper obtained was fairly satisfactory, but the consumption of chemicals was rather high. Further experiments will be carried out to try and reduce the consumption of chemicals.

5. A series of paper runs were made, using the samples of Indian china clays sent by Messrs. The Titagbur Paper Mills Co., Ltd., The Bengal Paper Mills Co., Ltd., and The India Paper Mills Co., Ltd., and a sample of English china clay, to test the comparative suitability of various clays as paper fillers. The experiments show that the Indian china clays are quite suitable and satisfactory and they are also reported to be cheaper than imported clays.

6. Experiments were carried out on the production of kraft pulp and paper from *Dendrocalamus strictus* (*salia*), sent by Messrs. The Orient Paper Mills Co., Ltd., and *Dendrocalamus longispatus* (*orah*). Whilst fairly satisfactory pulp was obtained, the paper produced was poor in strength, partly owing to defective press rolls on the paper machine and partly due to the lack of a jordan or refiner in the experimental factory. The experiments will be continued after the press rolls have been put right. The indications that good kraft can, however, be made in India from bamboos, are distinctly hopeful.

7. Packing paper was prepared from bagasse (crushed sugar cane) for exhibition in the Sugar Court at the Agricultural and Industrial Exhibition at Lucknow.

8. *Manufacture of paper, boards, etc.*—About four tons of writing, printing, type and packing papers and mounting and drying boards were produced in the experimental factory during the year under report.

About 2½ tons of paper and boards were supplied to the various offices of the Forest Research Institute and College, to the Government of India Press for the annual report, and to the Silviculturist, Punjab, and the Forest Research Officer, Bihar, for some special work.

9. The erection of the small mechanical pulp grinder obtained from Messrs. J. M. Voith (Germany), was completed towards the end of the year under report. Experiments on production of mechanical pulp from bamboos and a few selected species of soft woods will now be taken in hand.

## II. LABORATORY.

1. *Pulp for artificial silk*.—Experiments on the purification of bamboo pulp for the rayon and staple fibre industries were discontinued, pending the report of investigations by the Industrial Research Bureau on the possibilities of starting such industries in the country.

2. Experiments on the digestibility and bleachability of bamboo chips, supplied by the Kankinara Paper Mills, the Bengal Paper Mills and the India Paper Pulp Co. were completed and a report was made to the Paper Mills. The results confirmed the expectation that the opening out and the partial crushing of chips helped considerably in obtaining uniformly well digested and economically bleachable pulp.

3. Investigation on the causes of discoloration of bleached pulps and papers (one of the problems referred to the section by the Indian Paper Makers Association) was taken in hand. No conclusive results have yet been obtained.

4. Physical tests (tensile, bursting, folding, tearing, bulk, etc.) on papers prepared in the factory in connection with the experiments on the suitability of Indian china clays, were carried out and tabulated. The physical properties (specific gravity, grit, water of combination, etc.) of the various samples of clays were also examined.

5. Kraft pulps were prepared from *Dendrocalamus strictus* and their strengths (tensile, bursting and tear) were compared by the standard British Pulp Evaluation method with samples of three brands of wood kraft pulp obtained from Sweden. The samples of the Indian bamboo pulp sheets, gave a higher breaking length and burst factor than those of the pulp sheets prepared from the Swedish pulps. This demonstrates that it is possible to produce kraft papers from bamboo as good as the wood-pulp kraft papers imported into this country from Sweden.

Strength tests (tensile and bursting) were also carried out on ten different samples of Swedish Kraft papers, obtained from Messrs. The Vulcan Trading Co., Bombay.

6. Four grasses, *munj*, *kans*, *dab* and *gandor*, supplied by the Radhasoami Satsang Sabha, Dayalbagh, Agra, were tested for the production of bleached and wrapping papers.

7. Pulp and paper-making tests were carried out on *Andropogon schoenanthus* (botha grass) at the request of the Working Plan Officer, No. II Anantpur division (Madras).

8. *Boiler feed water*.—Routine analytical tests in connection with the softening of the boiler feed water were carried out as and when required.

### III. TOURS AND ENQUIRIES.

1. At the request of the Mysore Government, Mr. Bhargava visited Bangalore and Bhadravati in June 1936, to give advice to Messrs. The Mysore Paper Mills Co., Ltd., regarding the specifications of machinery for the Mills and other matters connected with the project of manufacturing paper in the State.

2. In August 1936, Mr. Bhargava visited Dayalbagh, Agra, to discuss a project for the manufacture of paper from grasses grown on the estate.

3. In September 1936, Messrs. The Orisnt Paper Mills Co., Ltd., invited Mr. Bhargava to Calcutta to discuss their project for the manufacture of paper.

4. Correspondence was carried on with Government departments, commercial firms and private individuals in connection with the technical enquiries referred to the section from time to time.

### IV. TRAINING OF APPRENTICES.

At the request of the Siam Government, two apprentices, Nai Sawai Supayasemsri and Nai Pairojna Dharmatcha, were admitted to the section, in September 1936, for training in the technology of bamboo pulp and paper manufacture. The apprentices have nearly completed their course of training.

### V. FOREST UTILIZATION CONFERENCE.

The Forest Utilization Conference, held at Dehra Dun in March 1937, recommended the following species to be tested for the production of mechanical pulp :—

1. *Broussonetia papyrifera*.
2. *Pinus longifolia*.
3. *Macaranga* spp.
4. *Excaecaria agallocha*.
5. *Bombax malabaricum*.
6. *Erythrina suberosa*.

7. *Butea frondosa*.
8. *Boswellia serrata*.
9. *Eucalyptus globulus*.
10. *Sterculia* spp.
11. *Abies pindrow*.
12. *Picea morinda*.
13. *Kydia calycina*.
14. *Gmelina arborea*.
15. *Tetrameles nudiflora*.
16. *Mallotus philippinensis*.
17. Teak saplings.

Experiments on *Broussonetia papyrifera* and *Pinus longifolia* have recently been taken in hand.

#### VI. GRANTS.

1. The Indian Paper Makers' Association (Messrs. The Titagbur Paper Mills, The Bengal Paper Mills, The Indian Paper Pulp Co. and The Deccan Paper Mills) contributed during the year Rs. 3,250 and Messrs. The Upper India Couper Paper Mills, Lucknow, Rs. 250 as a voluntary grant towards the expenses of the research work being done at Dehra Dun on problems of importance to the paper industry. These grants made by the Indian mills symbolizes the recognition of the value of research by the industry and insures close co-operation between the paper mills and the Forest Research Institute. Such co-operation can but react to the benefit of the industry generally.

2. The Imperial Council of Agricultural Research has also made a grant of Rs. 15,000 to the Forest Research Institute, for investigating the possibilities of manufacturing wrapping papers, insulation boards, straw-boards, etc., from bagasse (crushed sugar cane). Arrangements for carrying out the investigations are well under way and it is expected that experiments will shortly be started.

#### Timber Development Section.

This section was inaugurated from 1st April 1936.

The Timber Development Officer made a start by writing up some short popular booklets on the following subjects :—

1. Wood's challenge to steel and concrete.
2. Relative economy of wood, steel and concrete structures.
3. Manufacture of small dimension stock as a rural industry.

4. The truth about fire hazard in timber structures.
5. Cheaper and better gable roofing with wood shingles.
6. Treated wood for earthquake resistant structures.
7. Treated wood poles for electric distribution and service.
8. Preservation of Indian wood with Ascu wood preservative.
9. Special factors affecting timber design.
10. Better and cheaper fencing.
11. How to build earthquake and storm-proof houses.
12. Superiority of treated wood as modern structural material.
13. Relative cost of treated electric poles and overhead construction in India and abroad.
14. Specifications for treating wood poles for overhead electrical construction.
15. Treated timber bridges for Indian highways and railways.
16. The role of timber in hangar and aerodrome structures.
17. Wood *versus* steel for framed buildings.
18. How to build fire-resistant timber structures.

In addition, several thousand leaflets describing the demonstration treated timber house, the demonstration treated timber highway bridge, and the demonstration laminated wood bowstring foot-bridge erected at the Lucknow Exhibition were distributed free to visitors at the Exhibition and to many engineers and others likely to be interested.

#### TIMBER DEVELOPMENT DEMONSTRATION AT THE AGRICULTURAL AND INDUSTRIAL EXHIBITION, LUCKNOW.

The Timber Development Officer designed the two demonstration timber bridges and the all-wood earthquake and termite resistant house at the Lucknow Exhibition. These were greatly appreciated and provided an impetus to the cause of wood in two important lines, namely highway bridges and earthquake resistant houses. One of the two bridges was designed for 8 British units of highway loading and had a clear span of 48 ft. and a width of roadway of 16 ft. No structural member of this bridge was longer than 25 ft. and no cross-section was larger than 12" x 12". All the bridge truss members were treated under pressure with Ascu. The bridge was successfully tested at Dehra Dun by loading it with a 12½ ton steam road roller and by having about a hundred men standing on it at the same time.

The second bridge put up at the Lucknow Exhibition was of a laminated type, in which the compression member was an arched bowstring consisting of sections not longer than 6 ft. each. The bridge was used

as a foot-bridge leading up to the house over some water and had a span of 22 ft. This bridge was designed to show that such bridges are very practicable. Bridges of this type can be used up to spans of about 100 ft. The sections can easily be standardized, and made on mass production lines, so that portable foot-bridges for longer spans are also practicable.

The all-wood demonstration house had 8 rooms (five downstairs and three upstairs). It had also an open cantilever verandah, and two glazed verandahs on the first floor and a good open verandah on the ground floor on the front side of the house. Two kinds of roofing, one of which was under experiment, were used on the house. A type of box-girder roofing, using Ascu treated 3 and 5-plywood, was provided for part of the roof and the remaining part had Ascu treated wood shingles. The experience gained at the Exhibition with the two types of roofing showed, that for conditions in India, the shingle roof is superior. In conclusion it may be said that this exhibition house definitely served its purpose in stimulating interest in treated wood structures.

#### TESTS WITH TREATED PLYWOOD FOR CHEAP ROOFING.

Several test roofing panels of 3-plywood and 5-plywood were installed in the Wood Preservation test yard on a framework at a sloping angle before the rains started in June 1936. Some of the panels were treated with Ascu alone and some were given a supplementary treatment with either petroleum asphalt suspended in crude oil, or with petroleum asphalt alone. Fine gravel was sprinkled over the asphalt when it was hot. After 9 months' exposure to the elements, including about 100 inches of rain, the indications are that all the joints of the treated panels, which were of imported alder, have stood up very satisfactorily against rain. The chief defect appears to be superficial splitting, which does not however appear to become much worse after the first 6 months. Observations will continue to be made on these panels and a note made in next year's report as regards their condition.

#### COLLECTION OF INFORMATION REGARDING THE AVAILABILITY OF COMMERCIAL TIMBERS.

During the year, questionnaires were sent out to all provincial Forest Departments asking for information regarding the availability of those species which might command good markets if treated with an efficient wood preservative. Considerable information of value has been collected as the result of this investigation.

## COLLECTION OF INFORMATION REGARDING THE COST OF ENGINEERING STRUCTURES USED IN PUBLIC WORKS DEPARTMENTS.

Questionnaires were also sent out during the year to the Chief Engineers of provincial Public Works Departments asking for information on the cost of the more important types of engineering constructions used by the department. Replies from most provinces have been received.

### TREATED WOOD POLES FOR OVERHEAD ELECTRICAL TRANSMISSION.

It is gratifying to record that as a result of the activities of the Timber Development Officer, practically all provincial Electric Inspectors have removed the ban on the use of treated wood poles by electrical licensees. This has resulted in numerous enquiries and schemes for utilising treated wood poles in place of the usual metal pole.

### TOUR FOR TIMBER DEVELOPMENT.

At the commencement of the year the Timber Development Officer toured India and met and conferred with several heads of Departments in Assam, Bengal, Bihar, the United Provinces, the Punjab, the North-West Frontier Province, the Central Provinces, Bombay Presidency and Madras Presidency. He also discussed the possibility of a more extended use of treated timber in harbour construction with the Chief Engineers of the Port Trusts of Calcutta, Bombay, Madras, Cochin and Vizagapatam.

### INSTALLATION OF ASCU WOOD PRESERVATION PRESSURE PLANTS.

At the commencement of the year, when the Timber Development Section was inaugurated, there were in India only two Ascu wood preservation plants working under the auspices of the Agriculture and Fisheries Department of the Madras Government, and two wood preservation plants belonging to the Ascu Wood Preserving Agency. During the year under review, the Government of Travancore started operating a large-sized plant and they have already treated a few thousand poles for electrical distribution purposes. The Government of Mysore also treated over a lakh of metre gauge and narrow gauge sleepers with Ascu, mostly of *Dipterocarpus indicus*. Several thousands of these sleepers were for the Madras and Southern Mahratta Railway. Messrs. Callender's Cable & Construction Co., Ltd., put up Ascu pressure treating plants in the United Provinces, Bihar, Bengal, Madras and Bombay. These plants were all designed to treat timbers up to 40 ft. in length and 18" in diameter. The Forest Department of the United Provinces also put up a small portable Ascu pressure plant in Haldwani division. The Government Carpentry School at Jullundur put up an Ascu pressure

plant. Building contractors in Amritsar and Lucknow put up two more Ascu pressure plants. The Vizagapatam harbour authorities started operating their Ascu pressure plant, and the State Engineer of Bastar started treating timber with Ascu under pressure in a 40 ft. cylinder. The Government of Mysore have expressed their intention of putting up a second plant for treating timber with Ascu. The Government of Hydrabad have also expressed their desire to put up one large-sized Ascu pressure treating plant and one small-sized experimental Ascu pressure treating plant. The State of Jodhpur and the Zamindari of Balrampur have placed orders for two Ascu pressure plants. In short, at the end of the year under review, there were twenty Ascu pressure wood preservation plants either actually functioning or definitely on order.

In view of the above facts it would appear that commercial wood preservation has definitely come to stay in this country. It is expected that there will be further developments to report by the end of next year.

Apologies are due to the Government of the Federated Malay States for the statement made in last year's report that the Government of the Federated Malay States had definitely decided to put up an Ascu plant. The mistake was due to a misunderstanding. Some experimental treatment with Ascu is being done in the Malay States but this is being done in an existing plant.

#### DEPUTATION OF OUTSIDE OFFICERS TO DEHRA DUN TO INVESTIGATE TREATED TIMBER UTILIZATION.

Mr. D. G. Plumley, State Engineer of Bastar State, and Mr. Jagdish Prasad, a Public Works Department engineer of the United Provinces, were deputed to the Forest Research Institute by their respective Governments to investigate and report on the question of a more extensive and efficient utilization of indigenous timbers in constructional work. It is understood that the latter's report is being printed. The draft reports of these two officers were very favourable to the cause of timber.

#### Mechanical Sub-Section.

1. Due to the heavy rush of work experienced during the year the existing staff was not found adequate to cope with all the orders. Nevertheless 500 jobs were completed during the course of the year, in addition to the usual large number of jobs of everyday routine.

2. In the Paper Pulp Section considerable alterations were made during the year under review. The lean-to machine shop on the north side of the paper pulp workshops was extended to take more machines. A 30 H.P. motor was installed there after providing the required electric

mains to run it. A main shaft drive for this motor was also installed. The new mechanical pulp grinding machine was erected in the extension on receipt. The disintegrator was dismantled from its old position and erected in a different position. The hamboo and grass cutting machines were also installed in their new places, and a press was made for making sheets of fibre boards from bagasse. The old defective digester was taken down and discarded. Specifications were prepared for a new digester and the digester itself was received at the end of March. New rustless steel liners for the rod mill were received during the year, and after removing the old ones, the new ones were grouted into position with the help of molten zinc. The chemical laboratory of the Paper Pulp Section was also extended and water and gas connections were provided. The south verandah of the Paper Pulp hall was enclosed for use as a paper store. The new laboratory heater, the standard pulp sheet machines and a pulp press were also installed.

3. In the Seasoning Section, one of the four new kilns of improved design was completed during the year. One of the humidity chambers was lined with galvanised sheeting, and a new door of an improved design was made and tested successfully. One very delicate piece of apparatus was made for the measurement of the diffusion of moisture in wood. Another delicate piece of apparatus of pure copper was built for the measurement of the thermal conductivity of wood and other insulating materials including liquids. Two sets of the various parts of the new electric moisture meters were made for trial purposes.

4. In the Timber Testing Section one Buckton machine was given a complete overhaul.

5. In the Wood Preservation and Timber Development Sections numerous heavy fittings were made for the three wooden bridges for the Lucknow Exhibition. A large number of fittings and bolts were also made for the wooden house for the Lucknow Exhibition. A small Ascu plant was erected and connected up with the laboratory plant.

6. On the electrical side, the three D. C. generators with their switch boards, all the electric motors of various sizes and their switch gear, all light and power wiring circuits, ceiling and table fans, and other miscellaneous electrical appliances in the laboratories of all branches were maintained in good order.

7. The 4 motor lorries, the fire appliances in the Institute, and the railway track and trucks were maintained in good order. The steam boilers were also maintained in good order.

## CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs :—

- (i) *Vitex negundo*, Linn. and *V. peduncularis*, Wall.
- (ii) *Curcuma angustifolia*, Roxb.
- (iii) Fish poisons.

B.—Oils and Fats :—

- (i) *Ximenia americana*, Linn.
- (ii) *Litsaea chinensis*, Lamk.
- (iii) *Bauhinia variegata*, Linn.

C.—Other products :—

- (i) *Eupatorium odoratum*, Linn.
- (ii) *Osyris tenuifolia*.
- (iii) *Saussurea lappa*, Clarke.

2. Forest Soils.

3. Miscellaneous enquiries.

### 1-A.—Drugs.

(i) *Vitex negundo*, Linn.—It was reported last year that new leaves of the plant (March-April) contain a glucoside (M. P. 154° C.) which in mature leaves is absent. It was also reported that this glucoside on hydrolysis with alkali breaks up into para-hydroxy-benzoic acid and another crystalline glucoside (M. P. 173-74° C.). Further work on the elucidation of its chemical constitution indicates that the molecule of the glucoside consists of three parts namely, glucose, para-hydroxy-benzoic acid and an unidentified substance, which is extremely sensitive to acids, least trace of which even at room temperature decomposes it into a dark brown amorphous substance, insoluble in any of the common solvents. Chemical investigation had led to our suggesting a tentative formula  $C_{20}H_{24}O_{11}$  for the parent glucoside and  $C_{13}H_{20}O_6$  for the second. Further work is in progress to isolate and identify the third part of the molecule of the glucoside.

*Vitex peduncularis*, Wall.—The leaves on successive extraction with different solvents yielded 3.7 per cent. extractives to petroleum ether; 2.5 per cent. to ether sulphuric; 1.3 per cent. to chloroform; 10.2 per

cent. to alcohol and 11.9 per cent. to water. The ether and chloroform extracts mainly consist of fats, resins, etc. But from the alcoholic extract an amorphous glucosidal substance has been isolated. Both the glucoside and its hydrolysis product being amorphous, much progress could not be made. This, however, is being examined in greater detail. Apart from the glucoside, a minute quantity of an alkaloid has also been isolated.

(ii) *Curcuma angustifolia*, Roxb.—Roots of various species of *Curcuma* are said to be pharmacologically active and in the Ayurvedic system of medicine are prescribed for various ailments. The main constituent of the roots is starch, though some possess varying amounts of essential oil and colouring matter also. The nature of the starch from *C. angustifolia* does not appear to have been studied, even though it is an article of trade (known as *taukir* or *tikhur* in Madras and Travancore) and the starch is considered as good as the true arrowroot and is given to infants and invalids. The sample of *Curcuma* examined here gave on successive extractions with different solvents the following percentages of extracts :—

	Per cent.
Petroleum ether . . . . .	6.0
Ether . . . . .	3.0
Chloroform . . . . .	0.7
Alcohol . . . . .	0.1

The roots contained traces of sugars and 60.0 per cent. of starch.

There appears to be some doubt as to its correct botanical identity and therefore detailed examination has been left over for future work.

(iii) *Fish poisons*.—During the year we have explored several other plant products which are reputed as fish poisons. Of these only *Millettia pachycarpa*, Benth., roots have given rotenone, total ether extractives being 3.5 per cent. At present, our work on fish poisons is only of an exploratory character and we are concentrating attention to discover those that contain rotenone or allied products, thus obviating, for the present, the tedious biological experiments which alone are the final test for their insecticidal value.

The existence of rotenone in *Millettia pachycarpa* is both interesting and important and work on this will be extended. The proper age of the roots and the season of collection appear to be important points to bear in mind. The other species *Millettia auriculata*, Baker, which is a pest in some of our forests, has not yet yielded any rotenone but the work is being continued.

It would be interesting to add that work on fish poisons is attracting the attention of the Government, and the Imperial Council of Agricultural

Research have spent, during the last year and a half a considerable sum of money on exploratory work.

### 1-B.—Oils and Fats.

(i) *Litsaea chinensis*, Lamk. Syn., *L. sebifera*, Pers. vern. *Maida Lakri* (Hind).—The work on extraction of lauric acid has already been mentioned in the past reports and it has now been extended to *L. chinensis* which grows commonly in some of the forests in the United Provinces. Its berries yield 64-74 per cent. of kernels containing 36-56 per cent. of a crystalline fat of the following constants:—

Specific Gravity at 30° C. . . . .	0.919
Refractive Index at 30° C. . . . .	1.4451
Iodine value (Hanus) . . . . .	6.3
Saponification value . . . . .	274.1
Acid value . . . . .	4.5

Further work has shown that the fat consists of 93 per cent. of trilaurin and as such it adds another source for the exploitation of lauric acid.

(ii) *Ximenia americana*, Linn.—A detailed examination showed that the main constituent glycerides in the oil are cerotic (15 per cent.); ximenic (hexacosenic) (15 per cent.); oleic (61.0 per cent.) and linoleic (7 per cent.). The interesting feature of this oil is the presence of a new unsaturated acid, ximenic acid, which has not hitherto been reported to be present in vegetable oils and fats. It belongs to the oleic acid series, forms a dihydroxy derivative M. P. 118-119° C. and on catalytic reduction is converted into cerotic acid. Further work on the elucidation of its chemical constitution is in progress.

### 1-C.—Other Products.

(i) *Eupatorium odoratum*, Linn.—The *Eupatorium* of American origin is known to yield essential oils, the main constituent of which is dimethyl ether of thymohydroquinone. The Indian species do not appear to have been studied and it was thought desirable to take up this investigation. Collection of this plant material was made in Assam but when received in Dehra Dun it had dried up and lost almost the whole of its essential oil, the yield being only 0.1 per cent. The oil was dark-green in colour, of density 0.9513 and refractivity 1.4975 at 20° C. A detailed examination of the oil will be made as soon as sufficient quantity of the plants is available.

(ii) *Osyris tenuifolia*.—Reference was made to the so-called East African sandalwood oil last year and the constants of the oil from Tanganyika were given. In order to be certain of the genuineness and

purity, it was thought desirable to distil the oil in Dehra Dun from the stem and roots of *O. tenuifolia*, both obtained from Tanganyika. Both the stem and the roots had 13.3 per cent. moisture and 3.6 per cent. of the light yellowish brown essential oil, having an odour similar to that of the Indian sandalwood oil but fainter and more pungent. The constants for the oil distilled in Dehra Dun and that obtained from Tanganyika are given below :—

	Distilled in Tanganyika.	Distilled in Dehra Dun.
Colour	Light yellow.	Light yellow.
Specific gravity at 20° C.	0.9574	0.9497
Refractive index at 20° C.	1.4996	1.5000
Angle of rotation	-47.1°	-55.47°
Ester value	Nil	16.4
Ester value after acetylation	181	220.

It is obvious from the above that the oil distilled in Dehra Dun is richer in alcohols. To determine the amount of santalol, the oil was fractionated at 4.5 mm. pressure when about 65 per cent. distilled at 160-165° C. This was the main fraction consisting mainly of the free alcohols and had a specific gravity 0.9526 at 20° C.; refractive index 1.5010; angle of rotation -58.14°; ester value 14.9; and ester value after acetylation 233.86. It reacted readily with phthalic anhydride to form an acid phthalate, a thick viscous oil, and attempts to obtain strychnine phthalate compound resulted in getting a viscous oil. On regenerating the sesquiterpene alcohols from this by saponification with alkali and steam distillation, an oil was obtained which resembled santalol in smell and had the following constants :—

Density at 20° C.	0.9771
Refractive index at 20° C.	1.5030
Angle of rotation	-43.5°

These constants are well within the limits for  $\alpha$  and  $\beta$  santalol but its further confirmation is necessary. On the presumption that the purified oil is santalol it represents about 45 per cent. on the original oil. This work is being continued.

(iii) *Saussurea lappa*, Clarke. vern. *Kuth*.—Further work on *kuth* (Costus root) grown in British Garhwal confirms the statement made last year that this product compares very favourably with that of Kashmir. The following table gives the description and essential oil contents of the samples analysed :—

	Moisture per cent.	Oil per cent. on zero mois- ture basis.
Roots from Bhuna nursery (10,500'), 1931 plants, collected in September 1936	15.3	3.1
From Bistola nursery (11,500'), 1931 plants (direct sowing) collected in September 1936	14.2	4.2

The roots from Kashmir, on average, contain 2—4 per cent. oil, according to age.

## 2.—Forest Soils.

An attempt is being made to study the nature of forest soils and for this purpose data is being collected. Soils from typical forests of *Acacia sundra*, *Shorea robusta* and *Tectona grandis* have been examined but the work is yet in a preliminary stage and it is premature to report results and conclusions. A number of analyses of stray samples of soils, received from forest officers, have also been carried out.

## 3.—Miscellaneous Enquiries.

(i) Certain manufacturers complained to us that match splints, from semal (*Bombax malabaricum*) grown in the United Provinces, are too dark, which colour deepens further on processing and that they therefore compare unfavourably with semal from Assam. On examination, it was noticed that the red brown colour was not on the surface only but permeated all through the cells of the wood. Solvent extraction removed the colouring matter which on examination was found to be acidic in nature. Consequently an alkali treatment followed by slight bleaching appeared to be the solution of the difficulty. After a series of tests, it was found that soaking of the splints in 1 per cent. caustic soda and subsequent bleaching with calcium hypochlorite (Perchloron) of strength—0.35 pts. in 100 pts. of water gave satisfactory results and the finished splints were very much lighter in colour.

(ii) A large number of analyses were undertaken on behalf of forest officers, officers of the Institute and other departments of the Government, and of these mention may be made of the following:—*Artemisia maritima*; tree killers; arsenated pulp boards; *Betula* sp., etc.

## Summary.

It has already been reported last year that the study of *Vitex negundo* and *V. peduncularis* was taken up with a view to discovering the active principle responsible for the medicinal properties attributed to these in the Indian system of medicine. *Vitex peduncularis*, for instance, is a well-known remedy for black water fever. Our investigations have shown that it contains a glucoside and an alkaloid, identity of both of which has not yet been established. From *V. negundo*, on the other hand, has been isolated a glucoside, constituents of which are glucose, para-hydroxy-benzoic acid and an unidentified substance. To para-hydroxy-benzoic acid could be attributed the antipyretic and disinfectant properties of this drug.

Of the fish poisons that are under investigation the discovery of rotenone in *Milletia pachycarpa* is interesting.

The study of the indigenous sources of lauric acid which has been mentioned in previous reports, has now been extended to *Litsæa chinensis*, the fat of which contains 93 per cent. of trilaurin. Another oil that has been investigated during the year is from the seeds of *Ximenia americana*. The discovery of a new fatty acid, which has been designated as Ximenic acid, is of interest.

Under the heading of essential oil has been mentioned the pleasant smelling oil from *Osyris tenuifolia* which grows in East Africa. The oil is very similar in odour to sandalwood oil and contains about 45 per cent. of a sesquiterpen alcohol which probably is santalol but its identity requires confirmation.

## APPENDIX I.

*Publications of 1936-37.*

Serial No.	Title of Publication.	Author.	Date of Issue.
FOREST RECORDS.			
1	Preliminary Survey of the Forest Types of India and Burma.	H. G. Champlon .	August 1936.
2	Results obtained with a timber drying kiln heated directly by Furnace Gases.	S. N. Kapur .	July 1936.
3	Standard and Commercial Volume Tables for <i>Dalbergia sissoo</i> .	M. A. Kakasai .	July 1936.
4	A Stand Table for Chir evenaged high Forest .	....	August 1936.
5	Minor Forest Products of Chakrata, Dehra Dun, Saharanpur and neighbouring Forest Divisions; Part I.—The Oil Bearing Seeds.	S. Krishna, S. V. Puntambekar and M. B. Balzada.	January 1937.
6	Entomological Investigations on the Spika Disease of Sandal (27) Chrysomelidae.	N. C. Chatterjee & G. D. Bhasin.	July 1936.
7	A Survey of the damage to teak timber by the Beehole-borer throughout the main teak-bearing forests of Burma.	D. J. Atkinson .	December 1936.
8	Immature Stages of Indian Coleoptera (19) Anthribidae.	J. C. M. Gardner .	August 1936.
9	Entomological Investigations on the Spike Disease of Sandal (28) Cicadidae (Homopt.).	N. C. Chatterjee .	August 1936.
10	New Indian Cerambycidae . . . . .	J. C. M. Gardner .	August 1936.
11	New Indian Tingitidae . . . . .	C. J. Drake & M. E. Poor.	July 1936.
12	Zwei neue Callirhipis mit ihren Larven (Sandalidae, Col.).	Fritz van Emden .	August 1936.
13	A note on Protecting Indian Structural Timbers against fire, termites, borers and fungi (rot).	S. Kamesan .	October 1936.
14	The formation of Heartwood and its amount in Deodar Timber.	M. A. Kakasai .	(In Press.)
15	Entomological Investigation on the Spike Disease of Sandal (32) Lygaeidae (Hemipt.).	N. C. Chatterjee .	(In Press.)
16	Cls Latr. et Anobiides nouveaux des Indes . . .	M. Pic . . .	(In Press.)
17	Immature Stages of Indian Coleoptera (22) .	J. C. M. Gardner .	(In Press.)
18	New Crocoterus (Platypodidae Col.) . . .	C. F. C. Beeson .	(In Press.)
19	Seed Weights, Plant per cents., etc., for forest plants in India.	J. N. Sen Gupta .	(July 1937.)
20	Indian Terminalias of the Section of Pentaptera .	C. E. Parkinson .	(July 1937.)
21	Illustrations of Indian Forest Plants, Part IV .	C. E. Parkinson .	(July 1937.)
22	Entomological Investigations on the Spike Disease of Sandal (29) Coreidae & Berytidae (Hemipt.).	N. C. Chatterjee .	October 1936.
23	Some new Carabidae from India . . . . .	H. E. Andrewes .	December 1936.
24	Immature Stages of Indian Coleoptera (20) Carabidae.	J. C. M. Gardner .	December 1936.
25	Neue Brentiden und Lyciden aus Indian . . .	R. Kleine . .	January 1937.
26	Entomological Investigations on the Spike Disease of Sandal (30) Reduviidae (Hemipt.).	N. C. Chatterjee .	December 1936.
27	On the Biology of the Bostrychidae . . . . .	C. F. C. Beeson & B. M. Bhatia.	March 1937.

## Publications of 1936-37—contd.

Serial No.	Title of Publication.	Author.	Date of Issue.
<b>FOREST RECORDS—contd.</b>			
28	Entomological Investigations on the Spike Disease of Sandal (31) Dermaptera & Orthoptera.	L. Chopard & N. C. Chatterjee.	(July 1937.)
29	Immature Stages of Indian Coleoptera (21) Cleridae.	J. C. M. Gardner.	(July 1937.)
30	Second Interim Report on Work under Project VIII (Testing of Indian Timbers for Veneer and Plywood).	W. Nagle.	(July 1937.)
<b>OTHER PUBLICATIONS.</b>			
31	Annual Return of Statistics relating to Forest Administration in British India, 1934-35.	....	October 1936.
32	Annual Return of Statistics relating to Forest Administration in British India, 1935-36.	....	(In Press.)
33	Forest Research and Indian Industry	....	December 1936.
34	Rules for the Grading of Teak Squares (Reprint)	L. N. Seaman & V. D. Limaye.	April 1936.
35	Forests in relation to Climate, Water Conservation and Erosion.	....	(June 1937.)
36	The Forest Research Institute and College, Central Library, Classified Catalogue, 1934.	....	(In Press.)
37	Mercer's Tables (Reprint)	L. Mercer & Nand Mal.	(In Press.)
38	Progress Report on Forest Research work in India, Part I.—The Forest Research Institute, 1935-36.	....	December 1936.
39	Progress Report on Forest Research work in India, Part II.—Provincial Reports, 1935-36.	....	(May 1937.)
40	Classified List of Forest Officers of the Indian and Provincial Forest Services and of the Indian Forest Engineering Service in India and Burma on 1st July 1936.	....	February 1937.
41	Progress Report of the Forest College, Dehra Dun, 1935-36.	....	January 1937.

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Laurie, M. V.	What are the largest trees in the world? ( <i>Ind. Forester</i> , March 1936.)
Kakazai, M. A.	Dry weight factor for kosh (alder) firewood. ( <i>Ind. Forester</i> , April 1936.)
Champion, H. G.	The regeneration of tropical evergreen forests. ( <i>Ind. Forester</i> , May 1936.)
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Champion, H. G.	Maximum age attained by big timber trees. ( <i>Ind. Forester</i> , June 1936.)
Sen Gupta, J. N.	Best date for pre-monsoon planting of teak stumps. ( <i>Ind. Forester</i> , July 1936.)
Champion, H. O.	Effect of current forest management on future timber supplies. ( <i>Ind. Forester</i> , August 1936.)

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- Sen Gupta, J. N. . . . Regeneration of *gurjan* (*Dipterocarpus*). (*Ind Forester*, December 1936.)
- Kakazai, M. A. . . . Precision of the standard Indian sample plot method. (*Ind. Forester*, January 1937.)
- Champion, H. G. . . . Can you use a divining rod? (*Ind. Forester*, February 1937.)
- Kakazai, M. A. . . . Note on method of calculation of average crop diameter in sample plot work. (*Ind. Forester*, February 1937.)
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- Champion, H. G. . . . Which way conversion. (*Empire Forestry Journal*, Vol. 15, No. 1, 1936.)

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- Beeson, C. F. C. . . . *Martesia*: A Marine Borer. (*Ind. Forester*, Vol. LXII, May, 1936, pp. 286-289.)
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- Gardner, J. C. M. . . . A new species of *Dihammus* from India (Col. Cerambycidae). (*Proc. Roy. Ent. Soc. Lond.*, Vol. VI, 1937, p. 8.)

*Botany.*

- Parkinson, C. E. . . . Flowering of *Bombax malabaricum*. (*Ind. Forester*, March 1936, p. 165.)
- Parkinson, C. E. . . . A new genus of the Connaraceae. (*Ind. Forester*, May 1936, p. 295.)
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- Kamesam, S. . . . Potentialities of wood fuel and charcoal for cheap power production in India. (*Ind. Engineering*, March 1937.)
- Bhargava, M. P. . . . Prospects of the Paper Industry. (*Commerce*, 28th November, 1936.)
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## APPENDIX III.

*Statement showing Officers-in-charge of Branches and Sections during the year 1936-37.*

Branch.	Officer-in-charge.	Section.	Officer-in-charge.	From	To
Silviculture	Mr. H. G. Champion, Silviculturist.	..	..	1-4-36	6-10-1936
	Mr. M. V. Laurie	..	..	7-10-1936	31-3-1937
		Experimental	Mr. J. N. Sen Gupta	1-4-1936	31-3-1937
		Statistical	Mr. M. A. Kakazai	1-4-1936	31-3-1937
Botany	Mr. C. E. Parkinson, Forest Botanist.	..	..	1-4-1936	16-11-1936
	(Dr. K. D. Bagchee)	..	..	17-11-1936	16-3-1937
	Mr. C. E. Parkinson	..	..	17-3-1937	31-6-1937
		Mycology	Dr. K. D. Bagchee	1-4-1936	31-3-1937
Utilisation	Mr. H. Trotter, Utilisation Officer.	..	..	1-4-1936	31-3-1937
		Minor Forest Products.	Mr. H. Trotter	1-4-1936	31-3-1937
		Timber Testing	Mr. V. D. Limaye.	1-4-1936	30-6-1936
			(Mr. S. M. Hasnain)	1-7-1936	20-9-1936
			Mr. V. D. Limaye.	21-9-1936	31-3-1937
		Wood Preservation.	Mr. S. Kamesam	1-4-1936	31-3-1937
		Timber Development.	Mr. S. Kamesam	1-4-1936	31-3-1937
		Seasoning	Dr. S. N. Kapur	1-4-1936	1-7-1936
			(Mr. M. A. Rahman)	2-7-1936	3-3-1936
			Dr. S. N. Kapur	4-8-1936	31-3-1937
		Paper Pulp	Mr. M. P. Bhargava	1-4-1936	31-3-1937
		Wood Technology.	(Mr. H. Trotter)	1-4-1936	31-5-1936
			Mr. K. A. Chowdhury.	1-6-1936	31-3-1937
		Wood Workshop	Mr. W. Nagle	1-4-1936	20-3-1937
Entomology			(Mr. H. Trotter)	21-3-1937	31-3-1937
	Dr. C. F. C. Beeson, Forest Entomologist.	..	..	1-4-1936	3-4-1936
	(Mr. J. C. M. Gardner.)	..	..	4-4-1936	6-6-1936
	Dr. C. F. C. Beeson	..	..	7-6-1936	20-2-1937
	(Mr. J. C. M. Gardner.)	..	..	21-2-1937	31-3-1937
		Systematic Entomology.	Mr. J. C. M. Gardner.	1-4-1936	31-3-1937
Biochemistry	(Mr. T. P. Ghose, Officer-in-charge, current duties.)	..	..	1-4-1936	16-11-1936
	Dr. S. Krishna	..	..	17-11-1936	31-3-1937

## APPENDIX IV.

ANNUAL FORM No. 24.

## FOREST RESEARCH INSTITUTE.

*Summary of Revenue and Expenditure during 1936-37.*

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Utilisation Branch.	Chemistry Branch.	Total.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
<b>REVENUE.</b>							
<b>V.—Miscellaneous—</b>							
(a) Fines and forfeitures .	..	..	..	..	7,859	..	7,859
(b) Other sources . . .	700	181	62	49	..	21	908
(c) Leave contribution of officers on foreign service.	..	..	..	..	220	..	220
(d) Sales of timber and furniture from seasoning and wood workshop depot.	..	..	..	..	1,015	..	1,015
<b>Total Revenue .</b>	<b>700</b>	<b>181</b>	<b>62</b>	<b>49</b>	<b>8,594</b>	<b>21</b>	<b>9,557</b>
<b>EXPENDITURE.</b>							
<b>A.—Conservancy, Maintenance and Regeneration—</b>							
<b>C. 1.—Purchase of stores, tools and plant.</b>	<b>242</b>	<b>478</b>	<b>721</b>	<b>647</b>	<b>691</b>	<b>69</b>	<b>2,845</b>
<b>C. 2.—Communications and Buildings, Repairs and Maintenance.</b>	..	..	..	..	..	..	..
<b>C. 3.—Miscellaneous—</b>							
(1) Temporary Establishment on daily labour.	528	1,072	4,329	2,632	6,127	61	14,809
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	7,748	..	7,748
(3) Purchase of coal, raw materials, chemicals and apparatus.	..	..	..	131	9,960	1,599	11,690
(4) Other charges .	222	3,198	1,756	759	18,947	372	25,254
<b>Total A.—Conservancy, Maintenance and Regeneration.</b>	<b>992</b>	<b>4,743</b>	<b>6,806</b>	<b>4,169</b>	<b>43,533</b>	<b>2,101</b>	<b>62,344</b>

APPENDIX IV—*contd.*ANNUAL FORM NO. 24—*contd.*FOREST RESEARCH INSTITUTE—*contd.**Summary of Revenue and Expenditure during 1936-37—contd.*

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Utilisation Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
<b>EXPENDITURE—<i>contd.</i></b>							
<b>B.—Establishments—</b>							
<b>I.—Pay of Officers—</b>							
(a) Superior Officers—Non-voted . . .	25,866	16,400	..	34,843	21,659	..	96,668
(b) Superior Officers—Voted . . .	1,613	14,575	33,898	14,825	1,01,381	14,206	1,80,498
II.—Pay of Establishment . . .	39,650	21,781	9,393	21,003	98,102	6,485	1,96,393
<b>III.—Allowances—</b>							
(b) House Rent and other allowances—Voted . . .	529	..	..	..	..	..	529
<b>Travelling allowances—</b>							
(d) Superior Officers—Non-voted . . .	1,089	2,393	..	2,302	551	..	6,345
<b>Voted—</b>							
(e) Subordinate forest and depot establishments. } . . .	1,745	2,623	2,279	1,803	7,786	115	16,351
(f) Office establishments } . . .							
<b>IV.—Contingencies—</b>							
(a) Stationary . . .	159	1,415	9	11	8	..	1,602
(b) Carriage of records and tents. . .	676	556	781	145	215	..	3,373
(c) Rents, rates and taxes. . .	5,211	92	268	..	220	..	5,791
(d) Pay of menials . . .	..	..	..	..	..	..	..
(e) Official postage . . .	2,147	293	320	302	987	24	4,078
(f) Sundries . . .	11,794	388	698	834	1,745	962	16,421
(g) Clothing and uniforms. . .	428	99	82	162	316	45	1,132
(h) Telephones . . .	1,119	338	321	276	1,622	152	3,828

APPENDIX IV—*concl.*ANNUAL FORM No. 24—*concl.*FOREST RESEARCH INSTITUTE—*concl.**Summary of Revenue and Expenditure during 1936-37—concl.*

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Utilisation Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
EXPENDITURE— <i>concl.</i>	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
B.—Establishments— <i>concl.</i>	..	634	..	1,200	600	..	2,434
V.—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-voted).							
Total B.—Establishments	92,026	61,592	48,049	77,705	2,35,102	21,969	5,36,443
GRAND TOTAL OF ALL EXPENDITURE UNDER 8.—FORESTS.	93,018	66,335	54,855	81,874	2,78,635	24,070	5,98,787
Major Head 8-A.—Share of Capital Charges financed from ordinary revenue.	..	1,090	..	..	2,246	..	3,336
Surplus or deficit	—92,318	—67,294	—54,793	—81,825	—2,72,287	—24,049	—5,92,566

NOTE.— The figures given in this statement have been prepared in the President's office and are based on the Summary of Revenue and Expenditure for March 1937 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through the High Commissioner on Miscellaneous Items.

GERALD TREVOR,  
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Forest Research Institute and College.

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(This report has been printed on mixed species of bamboo paper made at the Forest Research Institute, Dehra Dun.)

# FOREST RESEARCH IN INDIA,

1922-23

## Corrigenda slip.

Page 157, 23rd line, after "April 1st" insert 1937.

Page 165, 24th and 25th line, for "manufactures" read manufacture.

provincial reports.

## Silviculture.

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*Assam.*—Progress continues to be made in standardising methods of regenerating the evergreens.

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*Bengal.*—The problem of the natural regeneration of sal remains entirely unsolved. Although the technique of sal plantations is well understood it is now obvious that the normal regeneration area cannot be worked upto under this system and that natural regeneration must be undertaken especially in the Bhahar



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# FOREST RESEARCH IN INDIA, 1936-37.

## PART II.—PROVINCIAL REPORTS.

### CHAPTER I.

#### GENERAL.

The research work carried on in provinces has made steady progress during the year. Silviculture receives most attention but increasing efforts are being made towards a fuller and better utilisation of the products of the forest. The appointment of special officers on utilisation has been of distinct benefit to trade. The following attempts to summarise the chief items of interest in the provincial reports.

#### *Silviculture.*

The all India teak seed experiment continues, several of the plantations have been thinned and made into sample plots. Unfortunately all the work done at Dehra Dun has been destroyed by frost which appears to be increasing in intensity in Northern India.

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*Bengal.*—The problem of the natural regeneration of sal remains entirely unsolved. Although the technique of sal plantations is well understood it is now obvious that the normal regeneration area cannot be worked upto under this system and that natural regeneration must be undertaken especially in the Bhabar

tract. Much interest has lately been taken in Kamrup methods and experiments on these lines are in progress. Much work has also been done on the natural and artificial regeneration of evergreens in Chittagong and the results are encouraging. The notching of *Dipterocarpus turbinatus* under high shade has proved very successful on a divisional scale at a low cost. In Darjeeling, *Cupressus torulosa*, *Cupressus cashmeriana* and *Juniperus virginiana* show much promise. A valuable little book on thinning in plantations by Mr. C. K. Homfray was published during the year.

*Bihar*.—The most interesting silvicultural experiment being carried out is the large scale contour trenching of dry hill sal forest in Chota Nagpur. There has been considerable correspondence and some controversy on this subject in the pages of the *Indian Forester*. The ultimate outcome of this experiment will be watched with interest. An experiment in controlled annual burning of sal has now been carried out in Saranda since 1923 and the results clearly show the benefits of complete fire protection in this type of sal forest. The plot burnt annually is in very poor condition, there is a characteristic barrenness of soil and several sal poles are top dry and have produced epicormic branches.

*Bombay*.—The thinning of teak plantations appears to be the great silvicultural problem confronting the staff. It is well known that the early and continued thinning of teak plantations is essential and steps to carry out this measure as a routine operation are very necessary not only in Bombay but in several other provinces. Some interesting observations on the growth of sandal are also in progress.

*Burma*.—Burma reports that the natural regeneration experiments on *Dipterocarpus tuberculatus* in East Katha division indicate that fire protection, though beneficial to the growth of regeneration, is not essential for establishment. *Pentacme suavis*, however, needs fire protection but has not much chance to hold its own against the former species where growing together. The effect of clear felling over existing natural regeneration of *D. tuberculatus* in Zigon division has shown a steady progress towards establishment of plants.

Experiments on stump-planting *versus* direct sowing or entire transplanting of teak confirmed previous years' results that the advantage of planting stumps begins to be lost in the third year. As regards early (pre-monsoon) planting of stumps, the indications have been that it would be unsafe to recommend very early planting in areas with less than 100" annual rainfall, though, if protected with a covering of loose earth, they can probably be planted

in areas with rainfall as low as 60". Stumps planted up to a fortnight after the break of rains were better off than seedlings transplanted entire. Stumps with root lengths between 4" and 8" are all likely to give the best results.

A number of experimental plots were laid out in areas where *Bambusa polymorpha* had flowered in 1935-36 with the object of raising a reasonable crop of teak there both by stumps and direct sowing. Results so far indicate a failure in practically all cases of experiments with sowing, whereas stump planting has proved admittedly superior.

In the teak seed origin experiments in Myitkyina, attacks by *Hoplohammus* have been much more serious on the crops from Indian seed origin than that from Burma origin.

Extensive work has been in progress with working plans. Interim measurements in the matchwood sample plots indicate that in a closed forest, growth of matchwood species, viz., *Sterculia*, *Bombax* and *Anthocephalus* is not very fast, as is often thought.

*Central Provinces.*—The natural regeneration of teak in North Chanda and the better class of forest following clear felling is generally unsatisfactory owing to the heavy undergrowth of bamboos. Methods are being worked out for felling the bamboos in a manner to foster natural regeneration. Moderate grazing and light shade seem to be factors favourable to teak regeneration in this province. Interesting experiments in the natural regeneration of *semal* (*Bombax malabaricum*) are in progress. The thinning of young teak is a major problem in this province.

*Coorg.*—A considerable amount of work has been done on the propagation and after tending of sandal. It appears that sandal is best grown as a road side tree or in lines widely spaced, that it should be given plenty of growing space and free circulation of air and never allowed to become parasitic on its neighbouring sandal. Sufficient good host plants such as *Cassia siamea* must be provided. It has been decided to plant a line of sandal along the outside of all teak plantations. The natural regeneration of the evergreen forests particularly of *Vateria indica* is becoming standardised.

*Madras.*—The importance of the *rab* method of regenerating dry fuel forests is shown by the fact that under ordinary coppice working 7 per cent. of the stools die at each coppice rotation. The gradual degradation of thorn and scrub forest worked under coppice is unfortunately a well known feature of Indian forestry and the *rab* system affords a method of rejuvenating coppice coupes by artificial regeneration. Further work has also been done on the

pre-monsoon planting of teak stumps and the correct size of stumps to use. Experiments continue to show that for teak, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Artocarpus hirsuta* stumps are preferable to any other method. Research has shown that the replacement of casualties in the second year of a teak plantation is of very doubtful value. Scraping as opposed to forking as a method of weeding young teak plantations is hardly inferior in results and gives an immediate saving of Rs. 3 to Rs. 5 per acre each time this operation is done. Experiments continue in the regeneration of evergreens and on the spike disease of sandal. The eradication of lantana by spraying with a sodium chlorate spray show that the method is the most successful and least expensive of any so far tried.

*North-West Frontier Province.*—The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*). The young regeneration suffering very heavy mortality in times of drought. The tube planting of *Pinus longifolia* has been used with success under very difficult site conditions at Cherat.

*Orissa.*—The natural regeneration of sal in Puri where evergreen conditions have become established is the chief problem of the new province. The thinning of teak plantations is also urgent.

*Punjab.*—The natural regeneration of deodar and the two pines *P. excelsa* and *longifolia* presents no difficulty. The regeneration of the firs has been a silvicultural problem for a long time and experiments confirm the opinion that excessive humus inhibits reproduction. 1½ million seedlings of *Morus alba* and *Melia azedarach* were handled in planting operations in the irrigated plantations. A useful record on mulberry by Mr. I. D. Mahendru was published. Considerable work has been done on exotics both in the plains and the hills. In the hills *Thuja plicata* has done very well and is much the most promising species tried. Counter erosion work continues to receive much attention throughout the province.

*United Provinces.*—The problem of first importance is the natural regeneration of sal *de novo* under the uniform system. Progress has been made and the position upto date is adequately summarised in Mr. Smythies article of April 1936 and Mr. Mobbs of August 1936 in the *Indian Forester*. Artificial regeneration on a large scale has now become a routine measure in many divisions both with and without *taungya*. Considerable attention is being paid to resin tapping investigations. Both here and in the Punjab treating blazes with a solution of Hydrochloric acid has not given an increased yield. The fourth edition of Mr. Howard's valuable Forest Pocket Book was published during the year.

*Botany.*

On the whole Divisional Forest Officers find little leisure for botanical work. Dr. Bor in Assam has been able to add a good deal to the knowledge of the grasses of Assam and several plants new to the Assam flora have been collected by Mr. Purkayastha. Generally the identification of tropical evergreens is the most important botanical investigation required and this work is being continued.

The progress of Forest Botany in Burma was continued by good work done in the Maymyo herbarium which was maintained in the usual good condition and to which additions of herbarium specimens were made from collections made by local Forest Officers and from a donation made by the Dehra Dun herbarium. An interesting collection from the Wa States on the Sino-Burma boundary was obtained by a collector who accompanied the Boundary Commission. The Maymyo Botanical garden continued to make good progress; additions in planting and to the orchid house and rose garden were made as well as improvements in the upkeep of the roads and lawns. The public continues to appreciate these gardens which stimulate and help gardening in Upper Burma in general and in Maymyo in particular where, it is pleasing to note, the Annual Flower Show has been revived after being in abeyance for six years.

*Entomology.*

The only possible way of dealing with epidemics of defoliators appears to be by methods of biological control and so far as teak in Nilambur and mulberry in the Punjab plantations are concerned this matter is being taken up in earnest. The Burma report contains some interesting particulars regarding the bee hole borer of teak which fortunately is absent from India.

*Utilisation.*

In several provinces the appointment of Utilisation Officers has increased interest in the most profitable exploitation of our forest resources. The utilisation of new species of timber, bamboos and grasses and the attempts to start new local industries making use of such products has made some progress but vested interests and conservative habits frequently stand in the way. It must be realised that it is useless attempting to develop a trade in any product which is not available in commercial quantities. Too often when uses have been found for a timber it is discovered that supplies are not available. In some provinces many sorts of timber can be

grown in plantations and it has not yet been decided what trees should be grown from the point of view of utilisation as opposed to silviculture. The grading of timber also demands attention, the grading rules for Burma teak are now published and are being examined in practice. Grading rules for other timbers produced departmentally in large quantities demand consideration. Revised specifications for sal sleepers were under investigation during the year and it is hoped that a specification having a nearer relation to reality than the present one will result. Box woods are in increasing demand and will have to be provided by plantations, the present scattered nature of these trees renders an annual supply at economic rates quite impossible. Burma as usual has been very active in all branches of timber utilisation and is fully equipped in this respect.

An interesting forest exhibit was staged by the United Provinces and the Forest Research Institute at the Lucknow Exhibition which attracted a good deal of public attention.

A Utilisation Conference was held in Dehra Dun in March at which many problems of current interest were discussed and some important resolutions passed.

## CHAPTER II.

## SILVICULTURE AND WORKING PLANS.

## ASSAM.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

*Staff.*—The post of the Silviculturist continued to remain vacant throughout the year. Mr. C. Purkayastha, Deputy Conservator of Forests, was in charge of the work in addition to his duties of Botanical Officer up to the 1st November 1936 when he was relieved by Dr. N. L. Bor, D.Sc., I.F.S.

It has not yet been possible to sanction even the minimum staff recommended by the third Silvicultural Conference in 1929.

A full programme of work was carried out in addition to the inspection of Divisional plantations.

There were 16 experimental plots (including the two experimental gardens) at the beginning of the year of which two were made over to the Division. Two more experimental plots were newly laid out while an old experiment of Sibsagar was reconstituted during the year.

(ii) *Natural Regeneration.*

## A.—Evergreen Climax Forests.

The investigations of the past few years have proved what has been known in Assam for a considerable time and has been prescribed in the working plans for Lakhimpur and Sibsagar, that the correct method of regenerating our *Dipterocarpus*—*Mesua* climax forest is to open the canopy, reserve a portion of the smaller trees and to tend the young growth. Experience has shown that after the forest has been exploited, advance growth of valuable species appears in quantity and will persist for many years even if it is not tended. Tending alone will ensure a considerable advance in the rapidity of growth, but cutting a number of the smaller trees in addition results in even better growth.

During the past year about 90 acres of an area in the Jeypore reserve, Lakhimpur division, which was exploited in 1927-28 and

tended subsequently for a number of years, was opened up by the Divisional Forest Officer by cutting a number of the smaller trees, bamboos and undergrowth. This operation revealed that the area was fully stocked with *Mesua* and *Dipterocarpus* and with a fair number of other valuable species such as *Magnolia*, *Manglietia*, *Amoora*, *Michelia*, etc. Many of these had already become established. Experimental plots were laid out in three areas in order to determine the comparative value of tending every year, every second year and every third year. Tending, by which is meant, the keeping down of creepers and cutting out of undergrowth interfering with valuable species, costs money, a factor which will continue to loom very largely in our treatment of these forests.

If the *Dipterocarpus*—*Mesua hylum* is a climax, that is, an organic entity produced and controlled by a given set of climatic factors, and there is no doubt that it is, it would be expected that it could regenerate itself without outside interference. It can and does reproduce itself, albeit very slowly, but since man takes a hand in the exploitation of the forest thereby upsetting the very delicate balance of biotic factors, he must also take a hand in controlling the luxuriant growth of weeds and climbers which are the result of this exploitation, if the replacement of exploited trees is the object in view. The greater the opening the more insistent will be the need for tending.

In the experimental plot No. 8 opened near Digboi, which had for its purpose the determination of the progress of regeneration under different degrees of canopy density, it was found that seedlings of valuable species up to 4' in height occurred all over the area. Since the canopy was opened the progress of recruitment has been little short of amazing. In one square 6' x 6' no less than 23 seedlings of *Artocarpus chaplasha* were found. The same result has been achieved over the whole plot where the terrain is not too steep.

*Darrang type evergreen*.—Experimental cleaning of undergrowth under mother trees of various species has shown that profuse natural regeneration can be obtained by this means; 3,300 seedlings were counted under one *honsum* (*Phaëbe goalparensis*) tree. *Bola* (*Morus laevigata*) regenerates itself with ease by this method but the foci prove very attractive to deer and the areas are not now cleared. The indications are that the undergrowth protects the young plants from deer and that they are able to make their way through it.

## B.—Sal forests.

(i) *Kamrup*.—All P. B. I. areas continued to improve on the progress made in the last 2 or 3 years. The luxuriant weed growth that characteristically invaded the groups when initially opened out has been brought well under control by selective rains tending. *Eupatorium*, it has been noticed, does not prove detrimental to the existence of sal seedlings though it certainly arrests their growth. On uprooting the weed, dense patches of healthy seedlings have been revealed in many places. This practice is now steadily followed and forms an important part of rains tending activities.

The methods now adopted for regeneration may be summarised as follows :—

- (a) In unopened areas.—(1) A preparatory felling involving an almost uniform removal over the area of the lower story of sal (consisting of suppressed and crooked stems and stems that would come out in a normal thinning) and of trees of miscellaneous species—except where their removal would result in a large gap in the canopy, (2) tending during the rains, involving cutting off of coppice shoots and shrubs, and the pulling out of weeds that become worse with cutting such as *Eupatorium*; (3) a carefully planned programme of forced burning all through the cold weather and (4) formation of groups by selective removal of trees in the canopy over promising patches of regeneration, to be gradually enlarged as regeneration progresses.
- (b) In the groups previously formed, regeneration work has mainly consisted of (1) selective rains tending and (2) careful practice of burning technique, followed by (3) extension by removal of trees on the edges of the groups as regeneration progresses.

(ii) *Kachugaon*.—There was a certain amount of seeding of sal trees in P. B. I. in Bamha block. According to Inspector General of Forests' recommendations, compartment 3 was selected for wholesale weeding of sal recruitment at the end of the year. In half of the area, weeding was done in lines 3' wide 6' apart, and in the other half all weeds were removed. It was found that the recruitment was not so good, specially in the area where only line weeding was done. These lines have been sown broadcast with sal seeds at the end of the year to supplement the recruitment. The whole of the area was fire-protected.

No thatch has made its appearance yet in the *sau* observation plot in the Bamba block. It will not be wrong to conclude now, after 5 years of experiment, that thatch will spread once it has come whether the area is burnt or not, but it takes long to make its appearance in any locality where it does not already exist.

(iii) *Darrang*.—Very considerable success has been attained by opening the canopy and tending sal recruitment.

### (iii) *Investigation of seeds.*

The most important problem to be solved is the germination of the valuable *Magnoliaceous* species found in Upper Assam that has just been taken up. These species, which possess seeds enveloped in a crustaceous testa, either show very poor power of germination or else remain dormant in the soil for considerable periods.

Germination tests were carried out on many species in the experimental gardens. Seeds of *Sageria* sp., obtained from the Silviculturist, Dehra Dun, failed to germinate in every case although they were distributed all over the province and sown in a variety of soils.

The following bamboos flowered during this year :—

*Cephalostachyum pergracile*, Lakbimpur.

*C. capitatum*, Khasi and Jaintia Hills.

*Dendrocalamus hamiltonii*, Sibsagar.

*Bambusa pallida*, Sibsagar.

*B. tulda*, Sibsagar.

*Dendrocalamus hookeri*, Khasi and Jaintia Hills.

*Arundinaria* sp., Khasi and Jaintia Hills.

### (iv) *Investigations on Trees and Crops.*

As in last year's report.

### (v) *Nursery Work.*

Nurseries are being opened at each plantation centre in evergreen divisions in order to raise valuable evergreens for transplanting.

### (vi) *Artificial Regeneration.*

(a) *Dipterocarpus macrocarpus*.—The reported low germination of this species is incorrect, for with correct selection of fruits as much as 70 per cent. germination can be achieved.

(b) *Lagerstræmia flos-reginæ*.—Results so far obtained from the stump planting experiment indicate that the early planting is far more preferable to the later.

(c) *Artocarpus chaplasha*.—The stump planting experiment of last year's report was repeated. A borer destroyed the leading shoot of nearly all the plants.

#### (vii) *Tending.*

Experiments have been laid out in *hollock* plantations in Lakhimpur to find out whether there is any advantage in spacing out the stems in 1 year old and 2 year old plantations.

#### (viii) *Mixtures.*

Experience has shown that mixtures of (1) *Amoora* and *Phæbe* and (2) *Altingia*, *Manglietia* and *Cinnamomum* grow very well together. Experimental plantations of various evergreen species are being started.

#### (ix) *Underplanting.*

Experimental plantations of *Mesua ferrea* and *Amoora* under *Terminalia myriocarpa* have been started.

#### (x) *Silvicultural Systems.*

Nil.

#### (xi) *Miscellaneous.*

A start has been made in systematising the record of preservation plots.

In all divisions a 10-year planting scheme is being drawn up and forms for standardising records are being issued.

### BENGAL.

#### I.—EXPERIMENTAL SILVICULTURE.

##### (i) *General.*

Mr. R. I. Macalpine, I.F.S., was in charge of the Silvicultural division upto the end of October 1936 and Mr. C. K. Homfray, I.F.S., from the 1st November 1936 till the 18th February 1937, thereafter Mr. S. J. Curtis, I.F.S., for a short term only till

Mr. J. C. Nath, I.F.S., took over from him on the 18th March 1937 and continued for the rest of the year. The Central Silviculturist and Silviculturist, Madras, toured in South Bengal with the Silviculturist, and visited most of the silvicultural plots in Chittagong, Chittagong Hill Tracts and Sunderhans divisions.

## (ii) *Natural Regeneration.*

(i) *Sal*.—In Buxa division attempts to naturally regenerate areas in the Bhabar tract have not yet met with very great success. As a result of the survey of the position made at the close of last year, the evergreen shrubs and coppice in the undergrowth were cut back and burnt, and the area (Santrabari plot) was weeded once in the rains, with the result that luxuriance of the undergrowth has been considerably reduced and there has been an appreciable increase of sal seedlings.

In the Raimatang Bhabar, though the replacement of *Pollinia ciliata* by *Imperata arundinacea* is slow, there has been an increase of sal seedlings, particularly where the canopy is more open and the undergrowth light. The conditions have not yet sufficiently changed to justify regeneration fellings and rains weeding.

In Darjeeling division, the experiments undertaken by the territorial staff have not yet yielded very hopeful results, though a certain amount of recruitment has been obtained where the canopy is open.

The Conservator of Forests and the Silviculturist visited Kamrup (Assam) in April and September 1936 to compare the Kamrup method and technique with those adopted in Bengal with a view to formulate a definite scheme for natural regeneration of sal in Bengal. A series of 12 experimental plots was accordingly laid out in different sal divisions for studying the applicability of the Kamrup method. The Divisional Forest Officers of Buxa and Kurseong also laid out similar plots. Besides, extensive areas in Buxa, Jalpaiguri and Kurseong were taken up, which were burnt with moderate intensity as far as possible. It is intended that by continued repetition of this process the present evergreen conditions of undergrowth (resulting from a prolonged fire protection) which have proved inimical to sal regeneration will be reversed. In many places, where conditions were too wet and undergrowth too evergreen to burn, focal points were started, where the undergrowth was cut and fired when dry. It is hoped that repeated burning from these focal points will result in ever widening areas of drier conditions favourable to sal regeneration.

In Dacca-Mymensing division, natural regeneration is of secondary importance, as coppice regeneration is quite satisfactory in the greater portion of the area. A careful study of the progressive growth of natural seedlings which are plentiful, was however, continued with the object of possibly replacing casualties in coppice stools or filling up blanks.

(ii) *Other species*.—(a) A series of plots have been laid out in Jalpaiguri division to study the effect of a burn of moderate intensity on the existing reproduction of *khair* and *sissoo* in the savanna areas in river forests and to see if this treatment would induce further recruitment of natural regeneration.

Experiments have also been started to regenerate natural grassy blanks in high forest in Buxa division by burning and controlled grazing, supplemented by rains broadcasting of seeds of miscellaneous species.

(b) *Evergreen forests of Kassalong, Chittagong Hill Tracts*.—The results of last seven years' work on these experiments, to determine a method of removing the existing overwood which would ensure an establishment of advance growth of valuable species already on the ground, are very encouraging. A large scale Divisional experiment has therefore been started to find out whether, and at what stage, it will be possible to carry out intensive fellings in such areas, as the success of departmental extraction largely depends on them.

(c) *Dipterocarpus* spp.—“Notching” of *Dipterocarpus turbinatus* under high shade on a Divisional scale has proved very successful at a low cost. But there has been very little success with *Dipterocarpus costatus* and *Dipterocarpus pilosus* and experiments with these latter species were continued.

An experiment to introduce *Eugenia grandis* by “notching” has also proved successful at a low cost.

Experiments on tending the patches of pole crops of *garjan* which occur throughout the Chittagong division were continued. The effects of cutting back the miscellaneous species and that of fire in reducing the undergrowth are being watched.

An experiment to test the suitability of the Kamrup method of natural regeneration of sal to *garjan* in Cox's Bazar has been started in a *Dipterocarpus costatus* area.

### (iii) *Nursery and Plantation Work.*

Nurseries were maintained at Takdah, Sukna and Hazarikhil.

*Takdah (Darjeeling).*—17 species of seed were sown during the year. Seedlings of these, mostly exotics, are planted out in the Darjeeling divisional plantations by the territorial staff. *Cupressus torulosa*, *Cupressus cashmeriana* and *Juniperus virginiana* are showing the greatest promise.

*Sukna (Kurseong).*—Routine experiments were made of various indigenous and exotic species. Those of interest are *Cassia siamea*, *Aleurites fordii*, *Pterocarpus marsupium* and *Eucalyptus citriodora*. *Acacia lenticularis* has done extremely well and shows promise of rapid growth.

*Hazarikhil (Chittagong).*—Routine tests were carried out for numerous species. Among the exotics *Xylia dolabriformis*, *Pterocarpus dalbergioides* and *Eucalyptus citriodora* show promise.

*Stump planting.*—Experiments on stump planting of various species were continued in many divisions. In Darjeeling, field nurseries of *buk* (*Quercus lamellosa*) and *phalant* (*Quercus lineata*) were started in all new plantation areas with the object of raising seedlings for stump planting in the future. In Kurseong, experiments with *buk*, *phalant* and *maya* (*Eriobotrya petiolata*) gave very good results. These experiments are of particular interest for hill plantations, where normally species raised from seed or transplants exhibit very slow growth and costs of tending are heavy.

*Fuel taungyas.*—These were continued in Kalimpong division with encouraging results. *Mandane* (*Aerocarpus fraxinifolius*), *lampati* (*Duabanga sonneratioides*) and *Albizzia* spp. seem to be the most promising for a 12-16 year rotation.

“*Kharkhani*” areas.—Experimental sowings of sal on bumps in a low-lying area (*Kharkhani*) in Buxa division are progressing well so far.

*Bamboos.*—The experiments at Baraiyadhala (Chittagong) on the introduction of the bamboos (*Melocanna bambusoides* and *Bambusa tulda*), in the poor, dry, deciduous forests were closed at the end of the year as they have fulfilled their object. One year old rhizomes are the best for the purpose and it is a practical and profitable proposition to plant rhizomes of *Melocanna bambusoides*, which has a greater local demand than *Bambusa tulda* in this type of forest.

An experiment to examine the possibility of introducing the exotic *Bambusa polymorpha* from Burma in the same type of forest has been started this year.

*Cover crops.*—Experiments on cover crops were continued. *Leucæna glauca*, *Tephrosia purpurea*, and *Lea crispa* are not considered as suitable as *Tephrosia candida*.

*Plantations of exotics in the Darjeeling Hills.*—Planting of exotics and other experiments were continued. *Alnus incana*, *Cupressus torulosa*, *Cupressus cashmeriana*, *Juniperus virginiana* shew promise of rapid growth.

Experiments to reduce the rate of growth of *Cryptomeria* by closer planting were continued.

*Mixtures in plantations.*—There is little to add to previous years' reports as it will take time to obtain conclusive results.

*Underplanting.*—Experiments with *Dipterocarpus turbinatus*, *Dipterocarpus pilosus*, *Dichopsis polyantha*, *Artocarpus chaplasha*, *Hopea odorata*, *Swietenia macrophylla* were continued with success.

*Thinnings.*—The thinning note (by Mr. C. K. Homfray) mentioned in last year's report was published during the year, and its principles were generally followed in silvicultural sample plots and divisional thinnings.

Experiments in earlier thinning of sal, viz., in 3 to 4 year old instead of in 6 year old plantations, with a view to reduce the tendency to form epicormics, were undertaken during the year; it is too early yet to form any opinion on the success of the experiment.

All other experimental thinning plots were maintained and remeasured as due.

*Eradication of climbers.*—As stated in last year's report, hoeing up of roots is the best method in young plantations. Coppicing of climber-damaged (due to *Tinospora cordifolia* and *Mucuna pruriens*) 5-10 year old sal, followed by a hot burn, cleaning and hoeing up of the climber roots, has proved very successful. In 2 years, the sal coppice attains a height of 8'-15'. In Jālpaiguri division 183 acres of sal plantation were thus treated with the result that they are now far cleaner, healthier and more vigorous than the original crop.

Experiments to study the effect of a burn of moderate intensity on the incidence of creepers were undertaken in Dacca-Mymensingh division, but it is too early to form definite conclusions.

*Controlled burning in sal plantations.*—Controlled burning in sal plantations, of over 8 years old, was carried out in Kurseong,

Buxa, and Jalpaiguri divisions for the eighth year in succession. This has resulted in reducing the evergreen undergrowth associates which are changing to a drier type and the general appearance of sal is more healthy than unburnt plantations. An annual burning of a moderate intensity is carried out in the cold weather.

All experimental plots to study the effect of controlled burning on the undergrowth, crop, soil conditions and cost of climber cutting were maintained. The results indicate that the operation is certainly beneficial.

Experimental plots were laid out in Dacca-Mymensingh to study the effect of annual burning of a moderate intensity on the incidence of a defoliator in sal.

#### (iv) *Preservation of Natural Flora.*

Twenty-seven plots were maintained and more plots will be laid out in due course.

#### (v) *Soil samples.*

Mention was made last year of a report from Dr. J. C. Ghosh, D.Sc., on the soil samples from sal forests. A further study of the corresponding soil profiles to draw final conclusions on the effects of burning in sal plantations will be taken up next cold weather.

#### (vi) *Special investigations.*

(i) *Pruning.*—Results of last year's experiments on sal in Buxa division indicate that pruning, either flush to the bark or down to the cambium layer, does not reduce the original number, vigour and growth of the epicormics, and that the pruning down to cambium is definitely harmful.

(ii) *Limitation of species.*—This is still under discussion and will, it is hoped, be completed at the next Divisional Forest Officers' Conference.

(iii) *Cryptomeria japonica.*—The closer planting experiments (by varying planting distances) to improve the quality of this timber by reducing the rate of growth were continued.

### II.—WORKING PLANS AND STATISTICS.

(i) *Working plans.*—The revised working plan for the Kalimpong division was published during the year,

The revised working plans for Chittagong and Cox's Bazar were still under compilation.

(ii) *Linear sample plots*.—Routine remeasurements were done to the old plots. A new plot was laid out in the Upper Hills of Kurseong covering species occurring between the elevation of 6,000 and 7,000 feet.

(iii) *Ring-counting and stem analyses*.—A bulletin containing up to date results for the more important species of the hills and the plains was prepared and sent to the Press during the year.

## BIHAR.

### 1.—EXPERIMENTAL SILVICULTURE.

#### (i) *General*.

Mr. W. D. M. Warren, I.F.S., was in charge of the division throughout the year, besides the charge of Working Plans and Utilisation.

#### (ii) *Natural Regeneration*.

*Contour trenching experiment in Palamau*.—Experimental plots were laid out to ascertain whether contour channel irrigation, by arresting the run off of hill side water, hastens the infilling of blanks with regeneration in dry sal areas. Only six sal trees of 6"–8" diameter surround the area, and at present none of these have specially good crowns, nor any regeneration present.

*Sal seeding, Palamau division*.—Two more experimental plots were laid out, to ascertain at what age sal coppice shoots give fertile seeds. Results from the existing plots shewed that seeds from 6 year old shoots gave no germination, from 7 to 11 year old shoots only 1 to 3 per cent. germination and from 13 to 14 year old shoots 10 per cent. germination, all in nursery beds.

*Burning, Saranda Experimental Plots*.—The fire protected plot shows fully stocked forest with ample regeneration. The middle-aged top canopy is sufficiently complete to prevent the underwood from developing rapidly. The underwood is thick and consists of sal regeneration, creepers such as *Millettia*, *Bauhinia*, and *Smilax* and regeneration of miscellaneous trees. Thinning in the overwood and cutting back miscellaneous trees and creepers, until the sal underwood is established, are considered necessary. The plot shows the usual healthy appearance of moist peninsular type sal forest.

The appearance of the experimental plot, annually burned for the last 12 years, is very different. There is no underwood of more than 2' in height, several of the sal poles are top dry and have produced epicormic branches and the few burnt-back seedling regeneration produce 2-3 unpromising shoots per stool, averaging only 2' in height with little fresh recruitment. There is a characteristic barrenness of soil with an absence of grass and vegetative cover and consequent surface erosion. Enumeration figures show that only 4 saplings have progressed to the tree stage since 1925, and that there are now no saplings and only 78 established regeneration as against 46 and 247 respectively in 1925. The appearance of the whole plot is that of an isolated dry area in the midst of healthy vigorous growing forest exhibiting the evil effects of annual burning for a number of years.

*Saranda Experimental Plots 3 and 15* were laid out in 1923-25 to ascertain how long it takes for sal regeneration to establish itself in middle aged, moist peninsular good quality sal forest with fire protection as against annual burning.

*Saranda Experimental Plots 5, 6 and 7.*—The object was to ascertain in these damp types of sal forest which of the three methods, viz., (i) burning once after clear felling, (ii) control, without burning after clear felling, and (iii) burning for five years before clear felling, will help sal regeneration to successfully compete with other mixed species. Results seem to suggest that burning after clear felling is not necessary to enable sal regeneration to compete with other species, but that a cleaning at some later stage is essential in order to free the regeneration from competition, and that continued burning before clear felling hinders definitely, rather than helps, the establishment of sal though it also hinders the evergreen species in competition with it.

(iii) *Seeds (collection, weight, germination per cent., etc.)*

A number of species were tried under germination test in nursery beds as well as under field conditions in the experimental garden at Hinoo.

*Teak.*—The simplest method of seed treatment giving good average results, is alternately to soak and dry the seeds on a cement floor until germination commences and then to sow the germinating seeds in beds at the correct distance (say 9" x 9") for future development. Seeds that do not germinate even after soaking and drying for about one month should better be put out straight into beds, much closer than the pre-germinated seeds (say at 3" x 3" or 3" x 6" apart). Experience suggests that seeds should be sown early

in May so that they may be germinating with the first showers of monsoon. Seedlings that had been crowded in germinating beds while planted out, showed much poorer growth than those left behind undisturbed. This, in fact, goes against too close a sowing in the germinating beds where seeds must be well spaced out with a view to the required number of future transplants. Experience has also shown here that one year old teak stumps can be stored, without damage, for at least 14 days before planting out, and can, therefore, be sent long distances.

### *Other experiments.*

*Cold weather stump planting.*—Out of six different species, put out in pits 1' deep and 6" squares in December 1935, *Bombax malabaricum* was the only species that came out successfully with a survival percentage of 96 and the average height of 10" on the 1st June 1936 and 76 and 13" respectively on the 1st June 1937. This height growth is definitely better than that of rains and hot weather stump plantings, which, however, gave better percentages of survival.

*Rains stump planting.*—25 stumps, with 9" root and 1" shoot, of each of the following species were put down in pits 1' deep and 6" squares on the 30th June, 1936. The percentages of success obtained and heights recorded on 1st June 1937 are stated below:—

*Tectona grandis* 84 per cent., 4"; *Bombax malabaricum* 84 per cent., 4"; *Acacia eburnea* 44 per cent., 16"; *Hymenodictyon excelsum* 97 per cent., 5"; *Pterocarpus marsupium* 80 per cent., 8"; *Albizia lebbek* 92 per cent., 7"; *Albizia procera* 92 per cent., 7"; *Acacia catechu* 80 per cent., 4"; and *Terminalia tomentosa* 48 per cent., 12". The last two species were stumps of two seasons old plants, the rest of one season old.

*Amoora wallichii.*—300 seeds were sown in nursery beds and in lines in field conditions in July 1936. In the following December the plant per cent. in the former was 85 with an average height of 6", while the latter had 70 per cent. with an average height of 5½".

100 entire plants, 3 months old, were transplanted in December 1936, out of which only 64 survived with an average height of 6" on 1st June 1937.

*Eucalyptus species.*—Australian seeds of *E. rostrata*, *E. macrocarpa*, *E. citriodora* (also from Forest Research Institute), *E. siderophloia*, *E. viminalis* and *E. tereticornis* were tested for germination and in the field with disappointing results. None can be recommended for general field conditions where attacks from

white ant are to be feared. Where conditions are favourable *E. citriodora* and *E. rostrata* may be tried, and entire transplanting from hoxes and from manured heds gave quicker growth than from pot tiles.

*Michelia champaca*.—Equal numbers of seeds which sank and floated were tested in the nursery bed and the germination per cent. was 46 against 57 obtained with good seeds only, yet in another test the floating seeds did not germinate at all. In either case heights in one season were 30", 20" and 10" for the highest, average and smallest plants respectively. The heds were shaded by bamhoo chicks. Germination was also tested in heds without shade. Good seeds, which had survived the water test, gave 27 per cent. germination against 22 per cent. given by the equal mixture of good and bad seed. The heights of one season old plants were 30", 20" and 10" for the highest, average and smallest plants respectively.

Seeds sown in hoxes without shade gave only 32 per cent. germination with average heights of  $3\frac{3}{4}$ ",  $2\frac{1}{4}$ " and  $1\frac{3}{4}$ " for the highest, average and smallest plants respectively in 3 months.

168 plants  $1\frac{1}{2}$  months old were transplanted in manured heds (6 kerosene tins of farmyard manure per hed of 80 square feet) 2" apart in lines 8" apart. The survival percentage is 89 and the average height recorded in June 1937 is 9". All the plants are growing very healthily.

*Robinia pseudoacacia* (Black Locust).—A water test was made with the seeds and those which sank gave 70 plant per cent. against 60 per cent. given by the unselected seeds. Germination took place within five days and the seedlings are very quick growing, the average height being 20" in one season. This species is reported from America to have a good spreading root system and well suited for fixing soil on unstable eroded lands and to survive under xerophytic conditions.

*Host plant of sandal wood experiment*.—Three months old entire transplants of *Santalum album* were put out in pits 1' deep and 6" squares in July 1936 under various host plants to determine which is the best host. Results so far indicate that *Shorea robusta* appears to be the best host plant, though plants under *Cassia siamea*, *Pterocarpus marsupium* and *Melia azedarach* are also promising. Survival and growth are discouraging under other host plants, viz., *Acacia macroflora*, *Albizia procera* and bamhoos.

*Bamboo planting in Palamau*.—14 seers of Angul *Dendrocalamus strictus* seed sown broadcast germinated well, but later

70 per cent. of the plants died. 16 pieces of mature bamboos about 4 feet in length were buried inside the ground. Before burying water was filled in the hollow portion by making holes in the internodes, the holes being kept up to prevent water from leaking. New shoots came out on 3rd August 1936 and looked very healthy but they are now all dead. On digging up a few pieces it was found that while shoots were thrown up from the nodes, no roots were sent into the ground.

*Aleurites jordinii* (tung oil) in Palamau.—All healthy looking plants were planted out in July 1936 which were living up to November 1936 after which rats began to attack them and out of 54 only 18 are now surviving.

#### (iv) Nursery work.

Nil.

#### (v) Artificial regeneration, including taungya.

Palamau.—Experiments are continuing with the planting of Indian and exotic species for beautifying the plateau. Water-logging and white ant damage are the two main problems to be tackled in the nursery. Coniferous plants show a tendency to damp off and draining has proved beneficial.

Of the species tried so far *Eucalyptus citriodora*, Cyresses and *Thuja orientalis* appear to do well though the first two are susceptible to attack by white ants.

Of the three species tried in the swamp plantation at Rud, viz., *Albizia procera*, sissoo and *khair*, *Albizia procera* (*siris*) did best and *khair* the worst.

#### (vi) Reclamation and afforestation.

Chaibassa.—Broadcast sowing in a protected forest block of *Zizyphus*, *Gmelina*, *Terminalias*, etc., and sal failed; even root and shoot cuttings of teak died.

#### (vii) Tending.

*Thinning Research*.—Two sets of research thinning sample plots were laid out in Saranda and Kolhan divisions, with a view to determining the age and intensity of first thinnings in young sal pole crops. Taking 7' average spacing as standard "C" grade thinning, "D" grade, 75 per cent. of "C", gave 8' - 1" spacing and "E" grade, 50 per cent. of "C", gave 10' average spacing

with enumeration figures of 1026, 769 and 512 respectively per plot. Subsequent inspection seemed to show that the "E" grade thinning is too severe.

(viii) *Mixtures.*

Nil.

(ix) *Under-planting.*

Nil.

(x) *Silvicultural systems.*

Nil.

(xi) *Miscellaneous.*

*Irrigation of dry hill sal areas, Kolhan.*—The contour trenching experiment at Bamiaburu continues to be a source of interest even outside the province.

The area was visited by the Inspector General of Forests in February 1937, who observed that all attempts to conserve moisture and prevent run off must be beneficial in areas of poor growth, and provided the work could be done at a reasonable cost were to be commended. Adoption of contour trenching would, it is hoped, increase considerably the yield of fodder for cattle in upland areas which cannot be brought under systematic cultivation.

His Excellency the Governor of Bihar also visited this area in June 1937, which has given the experiment great publicity in the press, and we may hope to find the principle more widely practised in the near future.

The Bamiaburu experiment now extends to 25 miles of trenches, about  $21\frac{1}{2}$  miles of which were added during the year, at a cost of Rs. 1,124, with Rs. 343-1-9 for meteorological instrument and chart papers. Another experiment was started at Roro, some ten miles away, where the first ten miles of trenches were dug this year.

*Contour irrigation, (i) Palamau.*—New perennial pools of water were observed to form in the *nala* at Mako. At Kundri the *palas* (*Butea frondosa*) trees along the trench seemed generally to produce bigger and much darker green leaves than those away from it. At Saidope, difficulty was experienced in keeping the trenches level. The Lat erosion experiment (not definitely contoured), started in 1934, gives one the impression that the influx of sal

regeneration will be slower here than at Bamiaburu with, however, a tendency for more to come in under the shade of mother trees.

(ii) *Chaibassa*.—Broadcast sowings of *Terminalias*, *Butea frondosa*, *khair*, etc., along with *Tephrosia* on the contour trenched area did very well, and thatch grass showed accelerated growth.

(iii) *Santal Parganas*.—Success also attended afforestation efforts in Dhamaniapahar where contour trenching aided the establishment of the species. Stumps of teak and sissoo and broadcast sowing of various tree species were used.

## II. WORKING PLANS AND STATISTICS.

### (i) *Working Plans*.

The Saranda and Kolhan plans were sent to the press. A miscellaneous working circle for systematic working based upon enumerations carried out in both divisions was added to each plan.

The revised plan for Chaibassa received the Conservator's final approval after the close of the year.

A preliminary report for the revision of the working plan for the Khurchutta reserved and protected forests was submitted.

With a view to meet the demands of the *Turis* (basket makers) of Porahat for green immature bamboos a scheme—called the Bamboo Basket Working Circle, has been drawn up for Porahat and inserted in the working plan as an appendix.

The thinning scheme which was prepared in 1935-36 was partly revised during the year.

A preliminary report for the revision of the working plan for the reserved and protected forests of Kodarma was submitted.

A working plan for the Khasmahal forests of Rohtas and Rehal was extensively revised and a 40-year coppice-with-standard rotation is being introduced on the lines of the Porahat scheme.

### (ii) *Yield, Volume, and Form Factors*.

Twenty sample plots were remeasured under full measurements of which one, of teak, was clear felled and the final yield recorded. Two single tree increment plots of *Adina cordifolia* and *Ougeinia dalbergioides* were laid out in Saranda division.

The collection of volume and outturn statistics of sal for Conversion Working Circle and Hill Working Circle coupes of Kolhan division was completed in some coupes and the registers sent to the Forest Research Institute, Dehra Dun, for statistical analysis.

## III.—MISCELLANEOUS.

(i) *Photography.*

A number of new photographs (120) were taken during the year and 4 new slides were added to the research collection.

(ii) *Weeds.*

Nil.

# APPENDIX.

## Germination test in nursery beds.

Serial No.	Species.	Date of sowing.	Period of initial germination - days.	Period of final germination - days.	Germination per cent.	Date of measurement.	HEIGHTS OF PLANTS.			REMARKS.
							Biggest.	Average.	Smallest.	
1	<i>Amoora wallichii</i>	6th July, 1936	12	63	85	December, 1936	9"	6"	3"	In box.
2	<i>Araucaria bidwillii</i>	....	..	Failed	..	....	..	..	..	
3	<i>Broussonetia papyrifera</i>	16th August, 1936	12	64	18	December, 1936	3"	2"	1"	
4	<i>Bixa orellana</i>	22nd April, 1936	20	121	8	Ditto	7"	4"	3"	
5	<i>Bambusa arundinacea</i>	....	..	Failed	..	....	..	..	..	
6	<i>Clausena pentaphylla</i>	14th July, 1936	21	46	1	September, 1936	2"	1½"	1"	Moistened seeds gave 7 per cent. germination.
7	<i>Callistemon viminalis</i>	22nd October, 1936	30	57	2	June, 1937	32"	18"	6"	
8	<i>Cupressus benthami</i>	....	..	Failed	..	....	..	..	..	
9	<i>Canarium euphyllum</i>	12th April, 1937	38	68	16	June, 1937	7"	5"	2½"	Seeds untreated.
	Ditto	Ditto	38	68	8	Ditto	6"	5"	2½"	Seeds soaked in mustard cake solution.
	Ditto	Ditto	36	68	10	Ditto	9"	7"	2½"	Seeds soaked in water for 72 hours.
	Ditto	Ditto	36	68	34	Ditto	8"	6½"	2½"	Seeds soaked in water for 24 hours.

*Germination test in nursery beds—contd.*

Serial No.	Species.	Date of sowing.	Period of initial germination—days.	Period of final germination—days.	Germination per cent.	Date of measurement.	HEIGHTS OF PLANTS.			REMARKS.
							Biggest.	Average.	Smallest.	
10	<i>Dendrocalamus strictus</i>	....	8	12	..	..	..	..	..	All died.
11	<i>Dalbergia sissoo</i>	15th July, 1936	7	27	67	October, 1936	1½"	1"	¾"	
12	<i>Erythrina stricta</i>	....	..	Failed	..	....	..	..	..	
13	<i>Gyrocarpus americanus</i>	....	..	Failed	..	....	..	..	..	
14	<i>Morus alba</i>	....	..	Failed	..	....	..	..	..	
15	<i>Melia composita</i>	....	..	Failed	..	....	..	..	..	
16	<i>Michelia champaca</i>	7th October, 1936	24	71	46	June, 1937	30"	20"	10"	
17	<i>Melia azedarach</i>	4th August, 1936	29	82	29	Ditto	12"	8"	3"	
18	<i>Ochroma lagopus</i>	21st March, 1937	12	14	1	Ditto	3"	..	..	In box.
19	<i>Pterocarpus macrocarpus</i>	22nd April, 1936	25	161	6	December, 1936	5"	6"	1"	
20	<i>Pterocarpus dalbergioides</i>	Ditto	18	161	7	Ditto	4½"	3"	1"	
21	<i>Pinus caribaea</i>	15th March, 1936	16	39	2	Ditto	2"	1½"	½"	
22	<i>Robinia pseudoacacia</i>	15th November, 1936	5	65	70	June, 1937	25"	20"	3"	
23	<i>Santalum album</i>	22nd April, 1936	30	83	5	December, 1936	8½"	8½"	2"	Mysore seeds.

	Ditto . . .	Ditto . . .	32	95	1	Ditto . . .	5½"	5"	1½"	Sambalpur seeds.
24	<i>Soyimida febrifuga</i> . .	10th July, 1936 .	6	27	12	Ditto . . .	2"	1"	½"	
25	<i>Sophora secundiflora</i> .	16th October, 1936 .	17	86	15	June, 1937 . .	2"	1½"	½"	

*Germination test in field conditions.*

(Line sowings.)

1	<i>Albizzia odoratissima</i> .	1st July, 1936 .	7	61	50	October, 1936 .	2"	1½"	1"	It is possible that damper forest conditions might produce bigger plants better able to withstand weed conditions. Ditto.
2	<i>Albizzia procera</i> . . .	Ditto . . .	7	24	58	Ditto . . .	3"	2"	1½"	
3	<i>Acacia catechu</i> . . .	Ditto . . .	6	36	60	Ditto . . .	4½"	2½"	1½"	
4	<i>Amoora wallichii</i> . . .	6th July, 1936 .	25	64	70	Ditto . . .	8"	5½"	2½"	Can be sown in field conditions. The sturdiness of the plants indicates that it might be able to withstand weed competition with the help of cleanings carried out.
5	<i>Acacia eburnea</i> . . .	14th July, 1936 .	4	22	11	Ditto . . .	1"	½"	½"	
6	<i>Bambusa arundinacea</i> .	....	..	Failed	..	....	..	..	..	
7	<i>Canuarina equisetifolia</i> .	1st July, 1936 .	24	92	5	October, 1936	2½"	1½"	½"	All died subsequently.
8	<i>Dendrocalamus strictus</i> .	....	20	21	2	....	..	..	..	
9	<i>Dalbergia sissoo</i> . . .	14th July, 1936 .	10	15	48	October, 1936	1½"	1"	½"	

*Germination test in field conditions—contd.*

Serial No.	Species.	Date of sowing.	Period of initial germination—days.	Period of final germination—days.	Germination per cent.	Date of measurement.	HEIGHTS OF PLANTS.			REMARKS.
							Biggest.	Average.	Smallest.	
10	<i>Eucalyptus rostrata</i>	2nd July, 1936	11	14	17	November, 1936	4½"	2½"	1"	Australian seeds.
11	<i>Hymenodictyon excelsum</i>	3rd July, 1936	12	26	16	October, 1936	1"	½"	½"	
12	<i>Morus alba</i>	2nd July, 1936	22	27	2	....	..	..	..	All died subsequently.
13	<i>Melia composita</i>	....	15	19	3	....	..	..	..	Ditto.
14	<i>Pterocarpus macrocarpus</i>	2nd July, 1936	75	83	1	October, 1936	1½"	..	..	
15	<i>Pterocarpus dalbergioides</i>	Ditto	34	41	1	Ditto	1"	..	..	
15	<i>Pterocarpus marsupium</i>	3rd July, 1936	15	26	39	Ditto	3"	2"	1"	
17	<i>Pinus longifolia</i>	4th July, 1936	26	47	16	Ditto	2"	1½"	1"	
16	<i>Schima wallichii</i>	1st July, 1936	10	43	12	Ditto	1½"	1½"	1"	
19	<i>Santalum album</i>	Ditto	50	74	7	Ditto	3"	2"	1½"	Mysore seeds.
	Ditto	Ditto	72	112	6	Ditto	2"	1½"	1"	Gambalpur seeds.
20	<i>Swidenia macrophylla</i>	2nd July, 1936	19	33	62	Ditto	6"	4"	3"	Seeds too scarce to justify sowing in field conditions.
21	<i>Soyimida febrifuga</i>	....	..	..	Failed	....	..	..	..	
22	<i>Stereulia aiata</i>	1st July, 1936	13	43	59	October, 1936	4"	3"	2"	

## BOMBAY.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The Chief Conservator's office continued to control research work of general interest. Due to separation of Sind the subjects pertaining to it were transferred to the control of the Conservator of Forests, Sind.

During the year 5 new plots were laid out in the Poona division, 3 at Bhimashankar to study the problem of natural regeneration in evergreen forest and 2 near Poona for observing the effect of sheep grazing on tree regeneration in an area hitherto closed to sheep. Registers in the standard forms and allocation surveys have been prepared for these plots.

(ii) *Natural regeneration.*Sandal (*Santalum album*).

*Subject No. 28.*—Effect of early burning on sandalwood growth and regeneration (Belgaum division).

The 3rd remeasurements of the trees in each of the plots 28-A and 28-B were taken in December 1936. The trees were reclassified into 1" girth and 3' height classes with the following result:—

				Plot A	Plot B
				(Fire protected).	(Early burnt).
				<i>Average girth.</i>	
Original measurement, 1933	.	.	.	4.97	5.59
I. Remeasurement, 1934	.	.	.	5.60	5.65
II. Do. 1935	.	.	.	5.63	5.65
III. Do. 1936	.	.	.	5.93	5.97
				<i>Average height.</i>	
Original measurement	.	.	.	12.12'	12.27'
I. Remeasurement	.	.	.	12.66'	12.84'
II. Do.	.	.	.	12.72'	12.87'
III. Do.	.	.	.	12.90'	12.83'

There is no significant difference in the average girth and height in both the plots. The leaders of 41 trees in plot A and of 35 trees in plot B are broken and this probably accounts for the poor average height. The Divisional Forest Officer reports that the only noticeable difference between the two plots is that natural regeneration is profuse in plot A while in plot B there is very little.

(v) *Artificial regeneration.**Hirda (Terminalia chebula).*

*Subject No. 37.*—Sowing and planting of *hirda* on laterite soil in the shade of existing shrubs or small trees (Poona and Satara divisions).

Out of the 60 seedlings and 66 transplants of *hirda* that survived at the end of last year in the 2 plots in the Poona division, 40 seedlings and 47 transplants are now surviving. The Divisional Forest Officer reports that the plants are sickly and have not put on much height growth. The average height of the plants is said to be about 6".

In the Satara division, *hirda* seed was sown in 100 pits (2 seeds in a pit) in laterite soil under the shade of bushes on the Mahableshwar plateau. Out of these only 27 germinated and 8 seedlings are surviving.

*Sandal (Santalum album).*

The Divisional Forest Officer, Belgaum, reports that tending of sandalwood plants raised in coupes 1 and 2 of Block XIX of Olmani, referred to in last year's report, was continued and that the plantation is in good condition.

The attempt made last year to raise *Bauhinia racemosa* on deserted village sites and fallow areas in the Tansa catchment area in the East Thana division as a means of minimising the danger from fire which is of annual occurrence in that locality, having proved impracticable on account of the heavy cost of weeding, the *rab* method of regeneration was tried during the year. Out of the several species sown on well burnt *rabs*, *Cassia siamea*, has shown the greatest promise of success as the plants have reached an average height of 3 feet 6 inches, look vigorous and are found to be immune to damage by browsing by wild animals. *Eugenia jambolana* and *Mangifera indica* are also promising though the latter are voraciously browsed by wild animals. It is intended not to do any elaborate weeding but merely to remove grass within a radius of 5' round the plants to minimise damage by fire.

*Tung trees (Aleurites fordii).*

Of the three surviving plants in the teak pole coupe of Block VI, Sambrani range in Kanara N. D. one died at the end of May and the other two are progressing satisfactorily. The height increment during the year is 13" in one case and 8" in the other

case. The plant at Tatwal which was 13" in height at the end of March 1935 has now attained a height of 20".

As the climate of the Haliyal Taluka is considered eminently suitable for this species a wet nursery has been prepared at Bomanhalli for further experiments and out of 396 seeds sown on 30th January, 77 germinated to end of March. The seed was sown 12" apart in raised unmanured beds and the present condition of the seedlings is fair. Germination commenced from the 26th of February and might possibly continue till 15th of April.

(vii) *Tending—Thinnings and cleanings.*

Teak (*Tectona grandis*).

*Subject No. 4.*—Effect of thinning on teak coppice at different ages (East Thana division).

In the East Thana division, 8 plots ranging from 8 to 15 years of age are under observation, the object being to find out the effect of thinning on teak coppice at different ages and the relative value of retaining one, two and three stems on each stool. Each of the above plots has been divided into two sub-plots (*a*) and (*b*). Sub-plot (*a*) has been left unthinned to serve as control plot and in sub-plot (*b*) one, two and three stems were respectively retained on stools bearing two, three and more than three shots.

Measurements of girth are to be recorded every two years and of height every ten years.

So far two remeasurements of girth have been recorded and the indications obtained are given below:—

- (1) The girth increment in the thinned plot is more than in the unthinned plot.
- (2) The crop thinned at 8 years of age, i.e., the youngest crop, has given the highest girth increment.
- (3) The girth increments put on by one, two and three stems left on a stool are:—

1 stem	.	.	.	.	.	.	23.61 per cent.
2 stems	.	.	.	.	.	.	18.63 „
3 stems	.	.	.	.	.	.	17.25 „
Control (all stems)	.	.	.	.	.	.	12.89 „

Many more remeasurements of girth are required for obtaining reliable data.

*Subject No. 34.*—Effect of different degrees of thinnings in teak plantations (Kanara N. D., E. D. and W. D.).

The next remeasurement is due in 1940-41.

*Miscellaneous species.*

*Subject No. 16.*—Effect of improvement fellings on diameter growth (Dangs division).

The 3rd remeasurement was taken and recorded in December 1936. For the purpose of comparison, the percentages of increment in the 3 successive remeasurements are given below:—

	1930.	1933.	1936.	Mean.
	Per cent.			
Plot No. 16-A (Improvement felled) .	14.1	10.5	12.46	12.35
Plot No. 16-B (Control) . . . .	4.1	4.3	5.83	4.74

The above figures conclusively prove that the diameter growth in the improvement felled plot is considerably greater, *i.e.*, over 50 per cent. than that in the control plot.

The experiment is being continued.

(xi) *Miscellaneous.*

Sandal (*Santalum album*).

*Subject No. 7.*—Annual girth increment of sandal (Belgaum and Dharwar-Bijapur divisions).

The next remeasurements in plots 7AI to IV and 7BI and II are due in May 1937 and November 1938 respectively.

*Subject No. 32.*—Correlation existing between the outer girth increment and heartwood increment of sandal (Dharwar-Bijapur division).

The two plots were inspected by the Divisional Forest Officer, Working Plans, S. C., in February 1937 and found to have been maintained in good order. The next measurements and borings in these plots are due in 1938-39.

*Phenological observations on teak.*

Under instructions from the Silviculturist, Forest Research Institute, Dehra Dun, phenological observations were undertaken on sets of 5 trees in each of the Panch Mahals, North Khandesh, North Thana, East Khandesh, West Khandesh and Kanara Northern divisions. The trees selected in the North and East

Khandesh divisions had to be abandoned as they were badly attacked by defoliators and most of them bore neither flower nor fruit during the season. Copies of records of the trees in other Divisions were sent to the Silviculturist after the close of the year.

*Enterolobium timbouva* Mart.

A small quantity of seed of *Enterolobium timbouva* Mart, received from the Argentine Republic, was sown in boxes at Mahableshwar in July 1935 but none of the seeds germinated. In December 1935 the seeds were taken out and again sown, but in baskets this time. One month after this resowing one seed germinated and after a month and half 6 more seeds germinated. Out of these 7 seedlings, 3 were alive in December 1936 of which 2 subsequently died. The solitary surviving seedling is said to be vigorous, its height being about 25 inches.

*Eradication of prickly pear by cochinial insects.*

The Divisional Forest Officer, Dharwar-Bijapur, reports that he noticed prickly pear coming up afresh in some places in the Badami and Bagalkot ranges where the killed material had not been burnt. It remains to be seen if this fresh crop will die out without the introduction again of the cochinial insect. The existence of any old swarms in the locality has not been observed.

## II.—WORKING PLANS.

The following plans were sanctioned during the year:—

Working plan for the Satara forest division.

Working plan for the Satmalla forests, East Khandesh division.

Working plan for the Casuarina plantations of Kanara W. D.

## BURMA.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

*Staff and programme of work.*—Mr. C. W. D. Kermode, Deputy Conservator of Forests, was in charge of the division throughout the year. Since the quinquennial programme of work was approved by the Chief Conservator of Forests, divisional forest officers have been submitting useful suggestions for silvicultural research into their local problems.

(ii) *Natural Regeneration.*

## (a) East Katha division.

*Dipterocarpus tuberculatus* (in).—Experimental plot No. 7 was laid out in 1922 to ascertain the effect of clear-felling on strips of various widths (1 to 3 chains) on regeneration existing at the time and on further recruitment. Half of each strip was fire protected and the other half burnt or left to nature. In the fire protected half there is now a dense regrowth of *Quercus* spp., *Lagerstroemia parviflora*, etc., and practically no *in*; while in the burnt strips there is now no regeneration in the 1-chain strip, a little in the 2-chain, and adequate (well on its way to establishment) in the 3-chain strip.

Experimental plot No. 9 was laid out to ascertain the results of burning, fire-protection and improvement fellings on the regeneration of *in* and *Pentacme suavis* (ingyin). The sub-plot, where improvement fellings were done in 1923 and since fire protected, has now an excellent pole crop of *in* as well as a fair number of established *Pentacme* regeneration; the one similarly worked (under improvement fellings) but burnt annually since 1923, has also a lot of *in* regeneration with abundant *Wendlandia*. Where no such fellings were done, the pole crop of *in* regeneration was much less with a few *Pentacme*, mixed with other species under a dense overwood in the fire protected area, and some established *in* regeneration with localised patches of unestablished *Pentacme* in the annually burnt area. The sub-plots gave indications that whereas fire-protection is beneficial to the growth of *in* regeneration, it is not essential, and that *Pentacme* which needs fire-protection for establishment has not much chance to hold its own in competition with *in*.

Experimental plots Nos. 12-19, laid out in 1925 to study the effect of different degrees of opening the overwood on the regeneration of *in* (*Dipterocarpus tuberculatus*), were not worked out to prescriptions. Instead E. P. Nos. 29 to 31 (A & B) were laid out in 1933-34 with the following treatments and results to date:—

E. P. No.	Initial condition.	No. of seedlings at formation (per acre).	Treatment.	No. of seedlings in February 1937 (per acre)
29	Regeneration sufficient .	5,690	Complete removal of canopy.	3,998
30	„ insufficient	420	Light opening of canopy .	483
31 (A)	„ 50% .	2,623	Complete opening of canopy.	2,415
31 (B)	„ Scanty .	1,725	Ditto . .	1,428

The method of enumeration by stocked squares has recently been introduced which will show hereafter the progress of regeneration in a more systematic way.

Experimental plots Nos. 20-25, with the general object of ascertaining whether regeneration of *in* in areas with a fairly dense overwood could be induced by hoeing or hurning the grass before seed-fall, indicated that after a steady progressive increase extending over 8 years (from 1926-33) there has been a falling off in the amount of regeneration since 1933 without any sign of progress towards establishment.

(b) Zigon division.

*Dipterocarpus tuberculatus* (*in*).—The experimental plot No. 4, laid out in 1927, to study the effect of clearfelling over existing regeneration of *in* has shown a steady progress towards establishment of seedlings. There are now 781 established (10 feet and over in height) *in*, 32 *pyinkado* (*Xylia dolabriformis*) besides 196 other associate species on one acre, fairly well distributed over the area.

*Pentacme suavis* (*ingyin*).—In experimental plots Nos. 1-8, in an evergreen type of forest in Myitkyina division, different treatments were given to the canopy, from cleaning of undergrowth to removal of all overwood except seed bearers, with and without burning, without any appreciable difference in results so far. The absence of natural regeneration of any size is remarkable. The experimental plots Nos. 9-11, to study the effect of soil working and broadcasting seed, resulted in very moderate germination but rapid dying off,—leaving only 5 seedlings in three plots.

(c) Dry upper mixed deciduous forests in the Shweho division.

Experimental plots Nos. 1 to 10 were formed in 1926-27 (and 11 to 15 in 1934) with the object of finding out if regeneration could be improved by preparatory fellings which included the felling of bamboo clumps. The general condition at present is that the felled bamboo has completely recovered and in practically all cases, there is now a heavy growth of bamboos densely covering the ground, and *Eupatorium odoratum* which had made its appearance in some places has now disappeared almost completely. Absence of control plots may not render results definitely attributable to treatments, but the following indications are worth noting:—

*Teak*.—The opening out brought in fresh recruitment of seedlings and the stock increased till 1929, but thereafter it gradually

tended to decrease. There are now 10 to 70 established teak plants per acre in every experimental plot.

*Xylia dolabriformis* (*pyinkado*).—Regeneration of this species is very low and its seed bearers are very few in the plots.

*Pterocarpus macrocarpus* (*padauk*).—There is a small amount of its regeneration in all plots, although like teak it started reasonably and continued well up to 1929. There is no sign of its establishment, only 3 trees in 10 plots have passed 15 ft.

*Shorea obtusa* (*thitya*) and *Pentacme suavis* (*ingyin*).—The experiment started with abundant regeneration in four plots and the 1933 counts showed an increase in all—profusely so in two. Most of their regeneration died off later and not a single plant has reached establishment height yet.

*Terminalia tomentosa* (*taukkyan*).—A fair amount of regeneration appeared after the original cleaning of bamboo, especially in 1928-29. It soon disappeared and the species seem to be intolerant of shade in early years in these dry forests.

Other semi-important species have also been kept under observation. Regeneration of all except *pyinna* (*Lagerstroemia* spp.) appeared in abundance in some of the plots, subsequently disappearing in most cases.

#### (d) Evergreen forests.

*Heritiera minor* (*kanazo*).—A series of plots (Nos. 1 to 5, Delta division) was laid out in 1934 in *Heritiera* forest with the object of ascertaining if there was any significant ( $\pm 30$  per cent.) alteration in quantity of *Heritiera* or other species due to (a) heavy opening of canopy and understorey by extraction and (b) light opening of the canopy and admittance of side light by fellings. Results so far are not conclusive. Except in one plot, heavily opened, there is a general increase of regeneration in all other plots. A marked difference is noticeable so far between a plot lightly opened and an untouched control plot, the former showing an increase of 70.7 per cent. while the latter only 5 per cent.

#### (iii) Artificial Regeneration.

##### A.—Experiments with teak stumps.

*Stump planting versus direct sowing and entire transplanting.*—The 1934 stump experiments, reported on last year, were remeasured during the year. The measurements confirmed last year's results

that the advantage of planting stumps begins to be lost in the 3rd year as would appear from the following tabular statement:—

Centre.	Method.	Growth put on			Total height.
		1st year.	2nd year.	3rd year.	
Myohla	Stumps, (31.5.34)	2.8	5.8	2.0	10.6
	Direct sowing (28.4.34)	1.1	4.3	2.4	7.8
Myohla	Stumps, (31.5.34)	2.1	8.9	3.8	14.8
	Direct sowing (28.4.34)	0.8	4.7	3.8	9.3
Nyaungbian-zin.	Stumps, (25.5.34)	2.9	4.7	2.3	9.9
	Nursery seedlings (17.6.34)	1.5	3.8	2.7	8.0
Xyunchaung	Stumps, (25.5.34)	2.8	12.7	9.2	24.7
	Seeds sown at stake (29.4.34)	1.3	8.9	11.9	22.1

*Early (pre-monsoon) planting of stumps.*—The 1935 plots were also remeasured at the close of the 1936 growing season. The two successive measurements shew that in the Ataran centres as well as at Sintesakan where the rainfall is high (about 200" and 95" respectively), the advantage of early planting before rains break is maintained in the 2nd year. The early planted stumps did better both in growth and survival when protected by piling loose earth on top. In places where the rainfall was below 60" percentages of survivals of early planting were low even when protected with earth. The indications are that it would be unsafe to recommend very early planting of stumps in areas of less than 100" annual rainfall, though if protected with a covering of loose earth, they can probably be planted in areas with rainfall as low as 60".

*Stump-planting at the break of rains and at 1, 2 and 3 weeks later.*—Experiments in planting of stumps after the break of rains mentioned last year, were maintained and remeasured. Results indicate that the advantages recorded last year of planting stumps upto a fortnight after the break of rains over the divisional methods of transplanting seedlings have been maintained in the 2nd year.

*Stump-root-length.*—The stump root length experiment, reported on last year, was remeasured and results tabulated. In the 1934 experiment the effect of different root lengths varying from 6" to 10" appears to be very slight—the 10" ones being slightly better than the rest. The 1935 experiments also do not lead to any new conclusion, and there seems no reason to depart from the opinion that stumps with root lengths between 4" and 8" are all likely to give good results.

*Patching experiment.*—At Sintesakan (Insein), very little difference was noted in the mean height of survivals of stumps and seedlings. Survival of seedlings was, however much better than stumps except stumps planted immediately at the break of rains. At Kunsan (Zigon) stumps put out at the break of rains and up to a fortnight thereafter shew a marked superiority to seedlings both in height growth as well as in the percentage of survival.

*Coppice experiment.*—The coppicing experiment of last year was remeasured. Results indicated that it would be of no advantage to coppice seedlings or stump-plants at the end of their first season's growth. The past practice of burning over new *taungyas* at the end of the first year and coppicing back seedlings might not, therefore, be a good policy.

### B.—Regeneration of *Pentacme suavis* (ingyin).

Experimental plots Nos. 14-17 in the Shwegu reserve, Bhamo division, were examined with the results as tabulated below:—

Plot No.	Treatment.	No. of <i>ingyin</i> plants per acre.		
		Unestab- lished.	Estab- lished.	Total.
		(Over 10' in height.)		
14 Sown in hood lines.	(i) Weeded and burnt . .	364	588	952
	(ii) Weeded and protected . .	260	1044	1304
	(iii) Unweeded and burnt . .	976	84	1060
	(iv) Unweeded and protected . .	536	200	736
15 Dibbled at stake.	(i) Weeded and burnt . .	336	580	916
	(ii) Weeded and protected . .	100	736	836
	(iii) Unweeded and burnt . .	1188	16	1204
	(iv) Unweeded and protected . .	504	356	860
16 Seed broad- cast.	(i) Weeded and burnt . .	864	64	928
	(ii) Weeded and protected . .	336	220	556
	(iii) Unweeded and burnt . .	552	..	552
	(iv) Unweeded and protected . .	368	40	408
17 Transplants .	(i) Weeded and burnt . .	1972	44	2016
	(ii) Weeded and protected . .	292	484	776
	(iii) Unweeded and burnt . .	1496	352	1848
	(iv) Unweeded and protected . .	444	96	540

It would appear that though fire protection is not essential provided that weeding is carried out; it has a marked influence on the crop, in that the fire protected plot shows a larger number of established plants than the burnt one. The figures also show that a reasonable amount of establishment can be got if weeding is done even though fire protection is not given. Success can be obtained either by dibbling or by sowing in hoed lines.

(iv) *Mixtures (in plantations).*

An experimental plot was laid out in a 1935 plantation in Zigon division to study the growth of teak and *pyinkado* (*Xylia dolabriformis*) in mixture. The latter was sown 6' x 6' over the whole area and one year old teak stumps were then planted in groups 6' x 6', the centres of groups being 30' apart. The teak now stands out conspicuously in little islands above the *pyinkado*. The table below shows the height growth of both species. Heights are in inches and decimals:—

Date of measurement.	Teak.		Pyinkado.	
	Percentage success.	Average height survivals.	Percentage success.	Average height survivals.
1	2	3	4	5
21-3-31 . . . . .	99%	40.4	96%	11.4
2-12-36 . . . . .	91.4%	97.7	89.7%	39.2

(v) *Regeneration of teak in areas where Bombusa polymorpha flowered gregariously.*

A large number of experimental plots (71 in all) were laid out in Pynmana and North Toungoo division in areas where *kyathing* bamboo (*B. polymorpha*) had flowered during 1935-36, with the object of producing a reasonable crop of young teak in the wake of the disappearance of bamboo growth. The plots laid out can be divided into 2 broad groups,—(1) experiments with stumps and (2) experiments with seed—each subdivided into a number of treatments, viz., planting at different times before or after rains break in the case of (1), and broadcasting, dibbling or patch sowing in the case of (2). All experiments were repeated both on level ground and slopes with different densities or espacements. Results to date are summarised below:—

*Early stump planting.*—Planted in the first week of May, percentages of survival were 60 at one place and 88 in the other with

mean heights ranging from 10.2" to 16" and 6.6" to 14" respectively.

*Stumps planted at break of rains.*—Percentages of survival were 86 at one place and 36 in the other, with mean heights ranging from 8.3" to 1.5" and 6.6" to 7.3" respectively.

*Late stump-planting.*—Planted in the 2nd week of June, percentages of survivals were 66 and 62 with mean heights ranging from 7.3" to 8" and 6.1" and 8" respectively.

Abundant weed growth appeared almost everywhere.

*Ordinary broadcasting.*—Seed was spread out as evenly as possible over the whole plot. Seedlings were counted on indicator lines, run across the plot, but very few seedlings were noticed.

*Patch broadcast.*—The seed, instead of being scattered, was laid down uniformly in small heaps at about 50 per acre. Results were very slightly more successful than ordinary broadcasting.

*Dibbling.*—Seeds were dibbled at 4 to 6 seeds per stake, without much success.

In fact in so far as one year's results indicate in all cases of experiments with seed, results have been a failure for all practical purposes; whereas stump planting gave some positive results that are admittedly superior to direct sowing both as regards percentage of survival as well as height growth.

#### (vi) *Investigation of the influence of seed origin in the case of teak.*

This investigation has continued for several years. Further sowings were done during the year in Zigon division. Seed of Travancore, Nilambur, Zigon, Khandesh and Mysore origins were tried. Khandesh seed was a complete failure. Casualties in the Nilambur, Zigon and Mysore plots were also very heavy. The old 1931 areas in Zigon and Myitkyina divisions were found to be so poorly stocked that no sample plots could possibly be laid out. In Myitkyina, attacks by *Haplohammus* on trees of Indian seed origin were noticed to be much more serious than on trees of Burma seed origin.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

Four working plans were sanctioned during the year, viz., for a portion of Bhamo (Kaukkwe), North Pegu, Northern Shan States and Thaton divisions. Work was also in progress on 19 other

divisional plans of which 9 were nearing completion. Necessary additions to and modifications of sanctioned working plans were also carried out during the year which included thinning and cleaning schemes for plantations and felling-cum-regeneration schemes elsewhere.

Some field work has been done in connection with stock mapping and estimating stock in the various types of forest in Zigon, Insein, Thaton and Upper Chindwin divisions. In the case of teak, enumeration of the stock is being done gradually at the time of girdling and complete figures will not be available for some years. Extensive forest surveys were carried out by different parties of the Survey of India during the year. Besides, local surveys were made by forest subordinates in different circles.

### (ii) *Yield, Volume and Form Factor Tables.*

Two new volume increment plots in teak and *pyinkado* (*Xylia dolabriformis*) were found and 92 existing sample plots were re-measured during the year.

Enough material has been collected for the preparation (by the Forest Research Institute, Dehra Dun) of yield tables for plantation teak in Burma.

An attempt has been made to determine the rate of growth of the three important species—viz., *Sterculia campanulata*, *Bombax insigne*, and *Anthocephalus cadamba*—constituting the *matchwood sample plots* in Insein division. The figures indicate so far that in a closed forest and growing in competition with other trees, growth of matchwood species is not very fast, as is often thought. Between themselves *Anthocephalus* is the most quick growing taking about 40 years to attain a breast height girth of 4 ft., *Bombax* next, requiring 70 years and *Sterculia* about 85 years to attain the same girth.

Girth increments of miscellaneous species have been worked out, also diameter increments of a large number of *teak* and *pyinkado* for the ten year period. The latter indicate an average annual diameter increment of 0.189" for teak and 0.157" for pyinkado.

### (iii) *Statistical Research in Irregular Crops.*

Crown space measurements collected in the two plots laid out last year were examined and statistical analysis shewed that two measurements of the crown at right angles were necessary for accuracy as single measurements led to under estimating. Some figures for ring counts of teak were received from divisions and worked out during the year.

## CENTRAL PROVINCES.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

1. A triennial programme of silvicultural research for the years 1936-39 was drawn up in consultation with the Central Silviculturist and approved by the Chief Conservator.

2. It is the policy to obtain natural regeneration following suitable fellings dictated by experience.

3. In certain forests, however, restocking by artificial means has had to be resorted to for special reasons. The high forests of Allapilli and Mobarli, where natural regeneration is almost impracticable due to prolific regrowth of bamboos and weeds are being restocked by stump planting with teak. Plantation work is being extended to convert the good quality mixed forests of Bilaspur to teak forests. The very open and heavily grazed forests of Yeotmal and West Berar, deficient in seedling and coppice reproduction, are being regenerated artificially by the agri-silvicultural method, which has proved so successful in these tracts.

Elsewhere plantation work is being carried out on a very small scale as an experimental measure only.

4. The following is a summary of observations of silvicultural interest from divisional reports:—

*Amraoti.*—In the conversion working circle with mature or overmature overwood there is a lack of advance growth of teak. A very small proportion of seed is fertile, which probably accounts for the paucity of seedling regeneration; coppice reproduction is also very poor. These, in clear-felled areas, soon get swamped by a rank growth of *Heteropogon ritchiei*. *Ougeinia dalbergioides*, however, is reproducing freely both from seed as well as from coppice.

*Balaghat.*—In sal forests, establishment of regeneration is largely affected by deer; and the occurrence of blanks is due to adverse edaphic and climatic conditions. Provided that adequate frost protection is assured the progress of established regeneration is dependent on the amount of light admitted to the forest floor.

*Bhandara.*—In the mixed forests the proportion of teak is gradually increasing (even when no apparent gaps in the canopy are created) due to overhead shade and light grazing.

*North Chanda*.—Heavy undergrowth of bamboos, following a clear felling, has been mainly responsible for the poor regeneration in the better quality forests. As a result of observations in Experimental Plot No. 6 and elsewhere, a method out of the difficulty now seems to have been found. Bamboos are now to be cut back in -10, -3, 0 and +1 years counting from the year of main felling to induce and foster teak reproduction.

*West Berar*.—The main problem is the best method of working the *anjan* (*Hardwickia binata*) forests. This species is a poor seed bearer, and seed years occur only once in 5 or 6 years. The leaves are much browsed by cattle to the detriment of regeneration. Measures to restrict grazing during the three years preceding the final felling, to run a light fire and to work up the soil; and after the felling, to completely close the area to grazing for a period of 7 years have been recommended to foster reproduction.

(ii) *Natural regeneration including coppice and root suckers.*

5. Due to abnormally heavy monsoon rains and frequent showers throughout the winter and the early part of the hot weather, the trees had a longer period of vegetative activity and most of the species, especially teak, burst into new foliage about two months earlier than usual. Intense heat towards the end of the hot weather, therefore, had a distinctly harmful effect, as most of the young leaves and even leaf buds were killed.

6. The following observations are reported from divisions:—

*Hoshangabad*.—A fair amount of established natural reproduction of teak is common in all the maturing or mature forests, except in places with long grass, or a dense under-growth of bamboos. The coppice regrowth is very rapid—35' high and 18" girth in 8 years—especially from stools under 2' in girth. Bigger stools have produced more numerous but weak and malformed shoots. In recently regenerated areas *Kydia calycina* has come up in great profusion which may very soon interfere with the teak.

*Nagpur-Wardha*.—Coppice reproduction of teak in almost all the areas worked recently under coppice with reserves or conversion is satisfactory but seedling regeneration is lacking, due to the rank growth of grass following clear fellings. On the other hand, in areas worked under thinnings in the past, the forest floor is covered with vigorous and thick advance growth, particularly of teak. This is due to the opening up of the cover combined with fire-protection and regulated grazing which encourage natural regeneration from seed by keeping back the rank growth of grass and

weeds. The thinnings carried out in the past were a bit drastic as they combined improvement fellings with a cutting back of bad growth, but they have done immense good to the forest by inducing seedling regeneration and invasion of teak into areas where there was no teak reproduction.

*Nimar.*—Natural regeneration of teak is excellent wherever the soil is of sufficient depth, the drainage is satisfactory and the grazing is moderate. In the forests on the Vindhyan sandstones, teak is the most aggressive species and a progressive succession by natural regeneration has already reached the climax over most of the areas. Most of the forests are dense and the proportion of teak, which is already high, is fast increasing. Everywhere, a pole crop of teak is most noticeable and the invasion of teak into almost pure *Boswellia* or *Hardwickia* forests very marked, although the best regeneration is mostly confined to the valleys leading into the Nerbudda.

In the trap forests also, natural regeneration of teak is satisfactory but wherever grazing is insufficient, it is not so good owing to the presence of tall grass. In forests where moderate grazing tends to keep down the grass, it is splendid, while teak regeneration is particularly absent wherever grazing is excessive.

*Yeotmal.*—In the teak forests on trap, prolonged closure to grazing does not help teak reproduction. The grass reserves that have remained closed to grazing for over 20 years have not filled up with tree growth so well as similar areas that have been open to grazing for 5 years after a 10-year closure. Moderate grazing helps regeneration everywhere and even heavy grazing does not adversely affect regeneration on plateaux and hill slopes strewn with trap boulders, but it impoverishes the soil and lowers the quality of the forest. The presence of miscellaneous species, particularly on poorer soils, is helpful to teak reproduction and also improves the quality of the locality.

7. In the mixed forests of Nagpur-Wardha there is a lot of teak reproduction in the thinned areas and more and more is coming up. But at the same time this rapid colonisation of these forests by teak is not confined to the thinned areas but occurs throughout the forests, wherever the factors of locality are favourable. Teak reproduction was found to have been scanty in 1895, but increased considerably since, as noticeable in 1925, till at present these forests contain extensive areas with 5 to 50 per cent. teak in them, the bulk of which is young to middle aged, and what is even more remarkable consists of all sizes inextricably

mixed as in a selection forest. These patches are rapidly extending with increased proportion of teak in them. The progress from a mixed forest (of the pre-reservation period) towards a seral teak forest appears to be due to radically altered oecological factors resulting from protective measures of conservancy and regulated methods of treatment. Generally this invasion by teak starts from areas where conditions of soil moisture tend to improve due to cessation of soil run-off, accumulation of decomposed leaf mould, and a gradual closing up of the canopy, which were not possible under pre-reservation conditions. The most typical instances are the areas under *Boswellia serrata* and *Madhuca latifolia* trees which have been left standing (without being destructively exploited) in the past. Other conditions being favourable, invariably the shade of these trees helps the teak to establish itself.

8. *Root-suckers*.—*Diospyros melanoxylon* is regenerating profusely by root-suckers everywhere, especially in the *maidans* in the sal forests near Kisli. Its tendency to regenerate by root-suckers in areas where its leaves are collected is a great advantage, as the leaves from the suckers are of a better quality for making *bidis* and can also be picked easily.

### (iii) *Seeds*.

9. *Seeding*.—It was a poor seed year for teak, which is attributed to a heavy attack of defoliators. Sal and *Hardwickia binata* seeded well; *Dendrocalamus strictus* seeded sporadically as usual; for other species it was a normal seed year.

10. As usual the Silviculturist acted as the distributing agency for seed, both inside and outside the province.

### (iv) *Nursery Work*.

11. The most important nurseries of the province are at Talwara (South Chanda), Deopur (Bilaspur), Balaghat Forest School, Umerda (Yeotmal) and Khadki (West Berar). The following interesting observations are reported.

*Deopur*.—The *dona* (leaf cup) system was evolved and perfected in this nursery. Though silviculturally ideal the method is becoming unpopular in practice, because when planting operations are undertaken on a large scale the forest villagers, in their hurry shove the plants into the *donas* carelessly; and the deformed root system caused thereby does not allow the plants to develop properly. The amount of care necessary to avoid this, and the watering for two months on covered platforms are costly. Transport of

*donas* is also difficult and expensive. The system is, therefore, gradually being replaced by stump planting.

*Balaghat Forest School*.—An effective and cheap means of weathering teak seed is to spread it on bamboo matting placed on bamboo platforms, about 18" above the ground, with the edges of the matting turned upwards so as to secure a slight sag in the centre to prevent the seed from being knocked down in a storm. It is important not to spread the seed more than 2 inches thick.

Few casualties occur among teak seedlings raised in *donas* provided  $\frac{2}{3}$  good loam and  $\frac{1}{3}$  manure is used. The *dona* method is particularly suited to the delicate seedlings of *Dalbergia latifolia*.

*Umerda*.—6,834 *Bambusa polymorpha* and 970 *Dendrocalamus strictus* seedlings from this nursery were transplanted over 100 acres in 18"  $\times$  18"  $\times$  18" pits towards the end of June 1936. In February, 40 per cent. of the plants were alive and doing well. The total cost including preparation of pits, transplanting, and mulching was 8 pies per plant. No weeding was required during the rains. Casualties were highest among the smaller seedlings and those planted on flat ground, or on stiff soil. Plants along slopes and under shade developed best. *Dendrocalamus strictus* seed was sown on 175 heds, 6'  $\times$  3', on 7th/9th July 1936. Line sowings gave better results than broadcasting, but heavy casualties were caused by hares. At the close of the year the seedlings were 9 to 24 inches high.

*Ornamental Tree Nursery*.—A small nursery has been started at Nagpur, where seeds of various arboricultural species were sown in June 1937.

### (v) Artificial Regeneration including agri-silviculture.



#### (a) Plantations.

12. Clear felling followed by artificial stocking with teak was started in 1933. These operations constitute the first large scale plantation work undertaken in the province. The spacing throughout has been 12'  $\times$  12' and 717 acres were planted up during the last 4 years (at about 180 acres per annum). The cost per acre has worked out at Rs. 6-6-0 on the average, exclusive of cost of fellings.

Experience in these plantations shows that stumps are preferable to *donas* and that the best results are obtained by planting stumps from 0.8 to 1.9 inch diameter at the collar. Early weedings in July and August are essential but need not be repeated

in the second year when all that is needed is to cut the herbaceous climbers and the overhanging culms of bamboos. Early planting reduces costs of weeding.

With a view to effect further economy various experiments are in progress, *viz.*, pre-monsoon planting in prepared pits; hall planting; stump planting under the mature wood 5 years in advance of main fellings; 6' x 6' and 9' x 9' espacement, etc.

13. *Balaghat*.—In the school forest, 8 acres were cleared and planted up 6'6" x 6'6", *i.e.*, exactly 1,000 plants per acre, with teak plants raised in *donas* alternating with miscellaneous species in single lines without any soil preparation, with a view to see if soil preparation could be dispensed with. Plants were weeded twice during the rains. A slight reduction in height growth was observed but no appreciable increase in casualties.

*Eucalyptus donas* planted over 2 acres also without soil preparation were 15" high at the end of the year; and nearly 75 per cent. of the plants survived.

2,000 teak *donas* were planted under the light shade of miscellaneous species. No weeding was done, nor was the area closed to grazing which is quite heavy. 50 per cent. of the plants were alive at the end of the hot weather.

14. *Raipur*.—The small teak plantations were extended and the regrowth from the plantations damaged by frost in 1936 withstood this year's frost.

15. *Bilaspur*.—43 acres were planted up (in different compartments) with mostly teak, *donas* and stumps from forest seedlings along with a few *Dalbergia latifolia* and mahogany. Results were generally satisfactory except in one compartment where the frost in January caused many casualties. The approximate cost excluding expenses on felling but including cost of raising plants and replacement of casualties worked out at Rs. 5 per acre. To reduce costs, and to encourage the coppice regrowth from miscellaneous species which protect the soil against insolation, the teak was planted with a spacing of 12' x 12' instead of 6' x 6' which had been the practice hitherto.

#### (b) Agri-silviculture.

16. *Melghat*.—About 300 acres of forest hadly infested with *Lantana* were given over to forest villagers (for a period of 4 years)

for the uprooting of *Lantana* and cultivation of field crops combined with sowing of seeds of miscellaneous tree species.

17. *Yeotmal*.—(i) *Kinwat departmental operations*.—34 acres of moderately stocked mixed forest of C. P. III quality, were clear felled in January 1936. The cut material was piled over the large stumps and burnt in the hot weather. After cross ploughing and harrowing the area was sown in the last week of May with treated teak seed, in lines 6 feet apart. Germination started on 22nd June and was very satisfactory. Between the teak lines, cotton was sown in lines 2 feet apart in the last week of June. The teak lines were weeded in July and again in August. The cotton crop was ruined by late rains, and the frost in January took a heavy toll of the teak seedlings. The plantation is, however, slowly recovering. Better results were obtained in 1936, but wherever stumps were introduced two years ago, the results have been more satisfactory. *Acacia catechu* was sown in 8 plots towards the end of June and germination was excellent. Teak seedlings were transplanted from the nursery to fill up blanks in the lines.

(ii) *Borwadi*.—18 plots. An area of 0.5 acre in each plot was selected in February 1936 in which all stumps were uprooted and the area thoroughly ploughed in March. Dry wood from the adjoining forest was piled on the site and burnt in May. Teak seed was sown in lines 6' apart on 23rd May and germination commenced on 22nd June and was very complete; one year old teak seed stored in white ant hills for about a month giving the best results. The few gaps were filled up by transplanting seedlings from last year's plots. The tenants sowed chillies and tobacco between the lines. The lines were weeded in July and again in August. In the first week of January a mild frost occurred which killed the shoots of some of the seedlings; these however sprouted later. During the last three years, 27 acres have thus been more or less successfully regenerated. The following measurements were recorded in March 1937:—

Year of plantation.	Height.	
	Maximum.	Minimum.
1934 . . . . .	16'	10'
1935 . . . . .	10'	6'
1936 . . . . .	2.5'	1.3'

18. *West Berar*.—Every year one coupe of 30 acres in each felling series is leased out for a period of 5 years for agri-silvi-

culture. In the first and second year only field crops are raised. In the third year *babul* seed is sown in lines 15' apart along with field crops, which are repeated in the last two years. The lessee is to sow the seed supplied by the Department, weed the seedlings, replace casualties, and in every way foster the plants during the last 3 years of his lease. If he fails to tend the lines, the work is done departmentally and the costs recovered. Most of the *babul* forests of Berar have been regenerated in this manner during the past 30 years, but experience has shown that pure woods of this species are very prone to fungal and insect attack. Recent management has therefore been directed to the introduction of a mixture of other species, of which the most suitable appear to be *Gmelina arborea*, *Pongamia glabra*, *Albizia lebbek*, *Dalbergia sissoo* and *Prosopis juliflora*.

### (c) Experiments.

19. *Regeneration from root-suckers.*—*Bombax malabaricum*. Innumerable seedlings come up in the rains under the older trees, but soon perish either from suppression or damage by wild animals. An experiment has therefore been started in South Chanda to determine the best method of establishing these seedlings. In a selected area, securely fenced against deer and pig, the overwood which consisted of miscellaneous species with a good proportion of *Bombax*, was heavily opened, all bamboos cut back, and the debris removed. In the rains of 1936 nearly 2,000 seedlings came up over an area of 1 acre. In February most of these were alive and had developed carrot-like roots about 75 inches diameter and 6 inches long. Their progress is being watched.

Experiments have also been started to study the possibility of obtaining regeneration from suckers by wounding the roots of standing as well as recently felled trees (*vide* article by Mr. Holland in the *Indian Forester* of December 1936).

Attempts are also being made to raise crops artificially by stump planting.

### (vi) Reclamation, afforestation and arboriculture.

20. *Arboriculture.*—138 pits 2' × 2' and 3' deep were dug on the rocky ground (in the compound of Kolsa Forest Rest House), filled with forest soil and fenced with bamboo mats. *Swietenia macrophylla* and *Eucalyptus citriodora* seeds were sown. The pits

were watered daily and although the seeds germinated well, about 10 per cent. casualties occurred due to attacks by white ants.

The camping ground in the Nagpur Civil Station was cleaned by the Nagpur Municipality and one year old seedlings of ornamental species were planted in prepared pits, 3' diameter and 5' deep, in suitable groves and glades under the supervision of the Silviculturist.

*Hoshangabad*.—Little is known about the correct intensity of thinning for young forests. Three typical coupes, regenerated in 1928, were selected and thinned to ascertain whether it would be possible to lay down roughly the number of stems per acre which should be left and to carry out the first thinning mechanically. The operations showed that while this can be done it is not desirable and that the thinning should be carried out according to the silvicultural requirements of the individual stems, as the crop varies considerably even within a very limited compass.

*Betul*.—Experience suggests that cleanings should not usually be delayed beyond about the fourth year. In reasonably accessible coupes it has been found that generally the price realised by the sale of the produce more than covers the cost of the operations.

*Balaghat*.—The original spacing of 6'  $\times$  6' of the 1930 plantation in the School forest was reduced in 1935 to 8½'  $\times$  8½' by mechanical thinnings when alternate diagonals were removed. Before thinning, the crop was said to be very congested and lack of space at the top is said to have caused development of branches lower down, a fact which was not recognised at first.

21. No definite scheme for thinning has been laid down as yet but an earnest attempt is being made to determine the optimum thinning regime suitable to our special conditions.

22. *Sal*.—It is now recognised that the first thinning in sal should be at 5 years of age and frequent thinnings carried out before the trees close up—as they appear to do after 30 or 40 years, to produce the typical “gummed up” effect. A start was, therefore, made in the earliest coupes of the Blue Block (Balaghat) where pruning of double leaders with the aid of light ladders, freeing from climbers, thinning out to give growing space all round was done to the great improvement of the dense coppice regrowth resulting from regeneration fellings.

23. *Babul*.—This is a strong light demander and heavy cleaning in the earlier stages and after about the middle of the rotation are essential, as otherwise the trees fall victims to disease. The optimum espacement is to just free the crowns of adjacent trees.

(vii) *Climbers and Weeds.*

24. *Bauhinia vahlii*.—In Amraoti this climber was dug out over an area of 40 acres and unweathered teak seed dibbled in the holes at a cost of Rs. 1-8 per acre. This resulted in the climber being exterminated wherever the operation was thorough, but the teak seed failed to germinate. In Balaghat the method (found successful in Seoni division) of cutting the climber 6" below ground level and ramming earth on the stump, has now been introduced. In Nagpur-Wardha also two  $\frac{1}{2}$  acre plots have been laid out where climbers were similarly cut and rammed, in March,—one in a fully stocked area, and the other in a similar forest recently felled under improvement felling-cum-thinnings.

25. *Lantana aculeata*.—In Amraoti eradication over 34 acres cost Rs. 1-13 per acre. In the Melghat, *Lantana* was pulled up with the help of elephants in the rains, and hurnt in the hot weather, a year in advance of the main fellings, over an area of 5,723 acres at a cost of Rs. 4,235.

26. *Dendrocalamus strictus*.—In the better quality forests of North Chanda bamboo regrowth is the main obstacle in the way of teak regeneration. As however bamboos are marketable and protect the soil it is not desirable to exterminate them.

(viii) *Mixtures.*

27. Due regard is being paid to the prescriptions in the working plans to favour the already aggressive teak over mixed species or to maintain a mixed crop for future according as local conditions would permit. In North Chanda the 1936 plan lays down that a mixture must be aimed at in the naturally as well as artificially raised crops. Accordingly in plantations teak is mixed with *Pterocarpus*, *Albizia lebbek*, *Dalbergia sissoo*, *Gmelina* and *Morus alba* as an experiment, these species being planted in several consecutive rows. In Juhulpore a patch of forest was discovered where teak and sal are growing together on black cotton soil. Examples of the two species growing together on sandy loam are common but not on trap.

(ix) *Underplanting.*

28. *North Chanda Experimental Plot No. 8 (1935)*.—The object is to observe the progress of teak stumps under a complete canopy of mixed forest, with an understorey of bamboos. The ultimate aim is to get sufficient vigorous teak plants established cheaply and with as little tending as possible, so that when the overwood is felled, and

the teak cut back the resulting coppice will outgrow the weeds and bamboo regrowth without any tending.

Stumps from previous year's forest seedlings were put out 9' x 9' in the rains of 1935. Casualties mostly due to white ant attack were 95.4 per cent. These were replaced by one year old nursery stumps in June 1936. Casualties after one month were 13 per cent., all of which were replaced. In February 1937, almost all the plants were alive and 4 to 6 inches in height with 2 to 4 leaves that were just beginning to turn grey.

29. *South Chanda*.—Similar experiments have been started to ascertain whether stump planting with teak, 5 years ahead of the main fellings in P. B. I. areas is more economical than burning and planting after fellings. Three treatments are under observation, viz., planting under (i) dense overwood and bamboo, (ii) light overwood and grass, and (iii) open overwood. Stumps were put out 12' x 12' on 2nd June 1936.

30. *Bilaspur*.—In an area planted with teak in 1930, some *Dendrocalamus strictus* seed was sown in patches, which germinated satisfactorily. It appears that raising of an understorey of bamboos by broadcast sowing presents little difficulty. *Cleistanthus collinus* is another species very suitable for growing under pure teak forests and trials will be made next year.

#### (x) *Silvicultural Systems.*

31. *Conversion systems*.—(a) *Teak*.—Experience shews that in the good quality teak forests, some form of conversion system is silviculturally inevitable, and that clearfelling with a view to obtain a normal series of age-gradations is the ideal method, provided that there is sufficient established teak reproduction to restock the area and a fairly complete demand. In the frost-labile forests on low lying areas, retention of part of the overwood either directly above the young crop or in strips as shelter belts, is considered essential. In forests which contain a dense understorey of bamboos, these are being cut a few years ahead of the main fellings to prevent suppression of young teak, as it is observed that bamboo regrowth is not very vigorous under cover. Bamboos are cut a second time along with the main crop, and if necessary, interfering culms are lopped in the year following the clearfelling. This prescription is proving very effective in the Bori and North Chanda forests.

(b) *Sal*.—Where regeneration of sal is very sparse, the conversion of such forests to even-aged stands resolves itself into

devising methods for inducing reproduction and getting it established. Little effort has so far been made to tend the existing advance growth or to induce regeneration where it is absent. *The sal forests of Baihar* (Balaghat) were worked under selection-cum-improvement fellings from 1900 until 1925, when they suffered for some years from a severe attack of the sal borer, which made it necessary to confine exploitation to attacked trees. The revised plan of 1932, prescribed for the first time conversion into even-aged stands by regeneration under a shelterwood, in a floating periodic block. The results in the first year's coupe were fairly satisfactory and to-day it contains a moderately well-stocked young crop about 20' high which has struggled through the bamboo regrowth. Another matter which deserves attention is the physical damage caused to the regeneration by the enormous quantity of slash left after exploitation, because small poles and fuel are not saleable, and the burn is never complete. More thorough burning, repeated in the second year if necessary, will go a long way in helping the regeneration.

In the frost-free forests of Raipur, conversion into even-aged stands under the uniform system with successive regeneration fellings, has been practised since 1924. The earliest coupes now contain a fairly uniform and well stocked pole crop 15' to 25' high and 1.5" to 2.5" diameter.

32. *Modified Coppice System.*—This system which has been applied to the mixed forests, and the inferior teak forests, in several divisions is not proving at all satisfactory. In the teak forests and in the dense stands of mixed forests of good quality, where the resulting vigorous coppice soon kills out the weeds and grass, the system has succeeded to a certain extent but not so in the openly stocked mixed forests, where the system degenerates into a wholesale clearfelling. Apart from resulting in a dense growth of tall grass the fire-hazard is also increased, and two or three fires in rapid succession can completely wipe out the forest. Similarly a frost can do very considerable damage in these incompletely stocked young forests. These dangers are reduced to a minimum by working these forests under the more conservative and elastic prescriptions of the *coppice with standards*, and more so, the *coppice with reserves* system which is tending to become the present policy.

#### (xi) *Miscellaneous.*

33. In P. B. I. in North Cbanda, where the dense bamboo and teak advance growth are cut some years in advance of the main

fellings, a controlled light burn is proving efficacious as it destroys the bamboo slash and results in more vigorous teak coppice growth. Wherever late fires have occurred in Hoshangabad, teak coppice has been killed outright or severely damaged, but recovers very quickly. More damage has taken place in the comparatively open mixed forests which contain seas of grass.

34. *Seoni Experimental Plot No. 2 (1935)* was laid out to determine the earliest stage at which rigid fire protection can be replaced by controlled early burning as a safeguard against fires in regenerated teak forests with a rank growth of *Imperata arundinacea*.

Plots are early burnt after 3, 4, 5, etc., years after main fellings and the effect on all the regeneration recorded. The experiment was getting unwieldy and, at the suggestion of the Central Silviculturist, it was simplified and the initial comparability of all the sub-plots more definitely established. It is too early to draw any conclusions except that burning in the second and third year is too premature as it kills most of the regeneration. An important observation made in this experiment is that as a result of two burns *Imperata* grass has diminished very considerably and its place is taken up by the comparatively harmless *Anthistiria ciliata*.

35. *Frost*.—A cold wave passed over the province between the 25th of December 1936 and the 10th of January 1937; a mild frost occurred on the night of 26th/27th December and a severe one on the night of 6th/7th January.

Very serious damage, particularly in clearfelled regeneration areas at the foot of hillslopes and in valleys is reported from many divisions, notably Nimar, Betul, Hoshangabad and Balaghat. Fortunately, the more valuable bamboo bearing teak forests are situated on the higher slopes, which are immune. The strip and group fellings started in 1935 in the sal forests of Jubbulpore appear to have achieved their object as the young sal escaped damage in the coupes of the High Forest Felling Series, while in the Coppice Working Circle, where the felled strips were 90 feet wide against reserved strips of 30 feet, only partial damage occurred.

In the sal regeneration coupes in the Balaghat division, the coupe, clear-felled in 1932, where regeneration is now about 20 feet in height, escaped injury but the younger coupes were badly hit and will need to be cut back. The retention for five years of a

shelterwood of 30 large crowned trees per acre has now been prescribed.

### *Grazing.*

36. Heavy and continuous grazing in the Pohara reserve of the Amraoti division has resulted in an increase of *Acacia catechu* and *Acacia casia*, both of which are thorny species and as such not touched by cattle. The proportion of inferior grasses such as *Eragrostis tenella* and *Andropogon contortus* is also increasing; whereas in an adjoining area, in which no grazing is allowed and grass is removed by cutting, the proportion of *Ischaemum sulcatum*, a good fodder grass, is increasing. In the C class forests which are permanently open to unrestricted grazing there is practically no regeneration and the quality and the quantity of fodder grass is steadily deteriorating. In several divisions the premature opening of regenerated teak forests to grazing, after a closure following the main fellings of 5 years or even less has been tried. This has not resulted in any appreciable damage by cattle to the young crop.

37. The grazing experiment in Yeotmal to determine the optimum incidence and periodicity of grazing and closures conducive to the gradual improvement of the wooded pastures is progressing very satisfactorily. The site selected is a forest on black cotton soil in the trap country. A similar experiment has now been laid out in Saugor on sand-stone to compare the variations due to the change in the soil and the underlying rock.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

#### Revision.

38. Revision of the working plans of North Chanda, Melghat and Raipur mixed forests was completed during the year and the plans were introduced with effect from 1st July 1936.

The following plans were under revision during the year:—

*Hoshangabad.*—The first ten yearly revision of the current plan of 1928 was considered necessary, to amend certain prescriptions in the light of experience gained in the last decade.

*Buldana.*—The revised plan will be based on a thorough stock-mapping of the forest and its main feature will be the systematic working of the *Hardwickia binata* forests which are a feature of the tract with which the plan deals.

## Amendments.

39. No important amendments were issued during the year.

(ii) *Statistical.*

40. *Sample plots.*—Owing to an unfortunate misunderstanding, the only teak sample plot in Betul was clear-felled. A new sample plot in C. P. IVh quality young teak forest was laid out in Nagpur-Wardha division. Thus the total number of plots, at the close of the year, remained unchanged, viz., 111. All of these were properly maintained.

41. *Tree increment plots.*—The existing 10 plots were maintained and no new plots were added during the year.

42. *Experimental plots.*—No new plots were laid out during the year.

43. *Management of bamboos.*—*Balaghat Experimental Plot No. 5 (1934).*—The all-India investigation with the object of determining the best method of working *Dendrocalamus strictus* for maximum sustained yield is in progress. 500 average-sized clumps are under observation in a practically virgin forest chiefly of *Pterocarpus marsupium*, *Dalbergia latifolia*, *Diospyrus melanoxylon* and *Bombar*, with an almost complete under-cover of bamboos. The clumps are divided into three sub-plots A, B and C which are to be worked on felling cycles of 3, 4 and 5 years respectively. Every year the production of new culms and the casualties of older culms are carefully recorded for each clump.

*In the Balaghat Experimental Plot No. 6 (1934),* the object is to study the life of individual culms. Condition of all culms in 20 cleaned and 20 uncleaned clumps is recorded from year to year.

Both the experiments are progressing very satisfactorily.

44. *Preservation plots.*—An up-to-date list of all the preservation plots and the permanently reserved single trees and groups of trees has been prepared.

45. *Inspections.*—All inspections and measurements due during the year were carried out.

## III.—MISCELLANEOUS.

46. The office of the Silviculturist was held by Messrs. H. C. Watts (1st April to 14th September), H. C. B. Jollye (26th October to 3rd March) and K. P. Sagreiya (rest of the year), Deputy Conservators. They together toured for 186 days during the year. The Central Silviculturist toured in the province from 1st February to 3rd March.

47. A number of photographs and stereoscopic pairs of various subjects were added to the collection.

48. *Ledger filing* of important notes is kept up-to-date as far as possible with the insufficient staff.

## COORG.

### I.—EXPERIMENTAL SILVICULTURE.

1. *Teak seed pre-treatment experiment*.—Routine pre-treatment experiments were carried out as in the previous year, the treatment being weathering in shallow pits, scorching, soaking 48 hours and 24 hours with an untreated control. These have produced good results.

2. *Teak seed storage test*.—Three tests were carried out with the same sample of seeds in three consecutive years. Seeds stored in air tight tins were sown and beds covered with straw, watering occasionally once or twice a week. Second year test gave a higher percentage of germination. The untreated control has given the best results and next comes soaking 48 hours.

3. *Germination test*.—(a) *Teak* (nursery).—The untreated control has given the best results and soaking 48 hours comes next. (b) *Santalum album* (sandal). As in 1935, seeds without pulp have again given good results. (c) *Evergreen species*.—The following species were experimented with:—(a) *Acrocarpus fraxinifolius*, (b) *Artocarpus hirsuta*, (c) *Swietenia mahagoni*, (d) *Pterocarpus dalbergioides*, (e) *Xylia xylocarpa*, (f) *Dipterocarpus indicus* and (g) *Cedrela toona*. *Acrocarpus* gave very low and *Xylia xylocarpa* high germination.

4. *Aleurites fordii* and *Aleurites montana*.—Nurseries were opened at 5 different centres where germination commenced in 4 weeks' time. Germinating seeds were then pricked out and planted in haskets filled with good forest top soil and cow dung manure.

5. *Oil palm cultivation*.—Seeds were sown to a depth of one inch in nursery beds at Makut, spaced 6' × 6'. Germination commenced in 2 months, and about 83 per cent. germinated. The seedlings in the nursery are coming up well.

6. *Bambusa arundinacea*.—Seeds were sown in nursery beds at three centres with about 80 per cent. germination in all, of which 50 to 60 per cent. are now surviving.

### *Sandal Regeneration.*

7. Sandal was experimentally sown in open and under bushes with *dal* (*Cajanus indicus*) and *Cassia siamea* as hosts. Better results were obtained under bushes where the percentage of germination and survival was 68 against 55 in the open.

8. The method of regenerating sandal by propagation centres in different ranges was continued during the year. In Tittimatti and Nagerhole, dibbling gave 90 per cent. success, while in Somwarpet, transplanting produced better results with about 65 per cent.; in Fraserpet it was complete failure.

### *Artificial Regeneration.*

9. *Premonsoon teak stump planting.*—Two experiments were carried out in 1934 and 1935. The mean heights of plants put out on 1st May 1936 were after the first season, 12·96" and 13·8" with survival percentages of 96 and 97 respectively. The best date for stump planting in Coorg would thus appear to be between the 25th April and the 10th May.

10. *Effect of taungya (kumri) crop on the growth of teak in a plantation.*—The results of experiments, repeated in 1936, also indicated that in many cases the percentage of survival as well as height growth were higher in the control, except in the case of paddy where the height growth of teak was better than in the control. The plants, which were from direct sowings, had however a height of less than two inches on the average, so that the results are not conclusive.

11. *Best planting distance for teak and its effect on height growth.*—Two experimental plots were opened, where three spacings were introduced, viz., 6' × 6', 4½' × 4½' and 3' × 3'. The seedlings in these plots were not burnt and cut back at the end of the 1st year, but at the end of the 2nd year two plots were burnt in the last week of March and seedlings cut back immediately after. Stocking was 85 per cent., but it is too early to give any other indications as the experiment is a long term one.

12. *Cover crops—Tephrosia candida (boga) introduced in a teak plantation.*—Some experimental areas, dibbled with teak and kumried in the first year of formation, *boga* was introduced in between teak (centrally in quin-cunx) in the 2nd year. In all centres the growth of *boga* was found to be good. Teak survival everywhere was better in the control than in *boga* strips, so also its height growth. This shewed that *boga* was harmful in the 1st and 2nd year of plantation as it suppressed the teak seedlings.

13. *To compare (a) weed cutting, (b) aeration by forking and (c) scraping with hoe.*—To determine the effect on the development of teak during the 2nd year of formation, measurements of seedlings have indicated that aeration by forking has given the best results both in survival and height growth.

14. *To compare teak (a) stumping and weeding, (h) stumping and scraping, (c) stumping and kumri (taungya) with ragi (Eleusine coracana), (d) sowing and weeding, (e) sowing and scraping and (f) sowing and kumri with ragi.*—An experimental plot was opened last year. Stumping has so far produced the best results both in survival and height growth. The growth of plants in scraped strips was found to be very good. The cover crop of ragi (*Eleusine coracana*) was found to retard the growth of young teak to a certain extent.

15. *Underplanting teak areas with Dalbergia latifolia.*—Observations in experimental areas of 1933-34 and 1935 were continued. About 80 per cent. of the plants exist but they are whippy and unhealthy.

16. *Effect of burning and cutting back a teak plantation in the 2nd year of formation.*—The experiment was repeated in a 1935 area that had been dibbled with teak and kumried in the first year of formation. The difference of growth between burning and cutting back is very little so far.

#### Miscellaneous.

17. *To study the growth of sandal in plantations with teak as hosts.*—The stocking of sandal was 60 per cent., plants being 8' to 12' in height; and the stocking of teak was 80 per cent., plants 12' high. Sandal is now being introduced round all young teak areas. Sandal sample trees have been selected in all working centres and girth measurements and conditions are being recorded for working plant purposes. Spiked sandal trees are treated with "Atlas", and as a result, the incidence of spike has considerably been reduced.

18. *Sandal spike incidence.*—In 1928 Hudgur plantation containing 12 acres of good sandal (about 25' high with an average girth of 12"), only 3 sandal trees were found spiked for the first time early in August 1936. The incidence has been carefully located, mapped and an ecological survey of all growth including shrubs, etc., up to a radius of 55' from the centre of infection has also been made. So far no other trees have been attacked.

19. *Sandal observation area of 1936.*—There has since been a considerable increase in the stocking of sandal except in one plot

where *Lantana* was uprooted, and stocking reduced by cattle damage. Results are being closely watched.

20. *Teak defoliation experimental areas in South Coorg*.—Defoliation was noticed in Tittimatti range in May in a severe form. In the eastern forests, however, it was not so severe.

21. *Experiment in the Closed Working Circle for eradication of grass*.—The object is to eradicate the dense growth of grass and to assist teak plants to develop. A small area was clear felled and burnt in early April 1936. It was then staked  $5' \times 5'$ , and dibbled with teak seeds and divided into three equal plots. In one, bamboo cuttings were planted at an espacement of  $10' \times 10'$ , in another, *Lantana* natural seedlings transplanted,  $6' \times 6'$ , and in the 3rd, bamboo natural seedlings introduced at  $10' \times 10'$ . The stocking of teak is 80 per cent., the seedlings being  $1' 6''$  in height.

*Lantana* has been established successfully and about 95 per cent. seedlings survive. Bamboo cuttings have been a complete failure.

22. *Regeneration in evergreen forests*.—Strip enumerations shewed that natural regeneration of important species, e.g., *Vateria indica*, *Hardwickia pinnata*, *Artocarpus hirsuta*, *Dipterocarpus indicus* and *Palaequium* was plentiful.

23. *Artificial regeneration work*.—So far *Hopea* transplants have yielded the best results. Next comes *Artocarpus hirsuta* and *Acrocarpus fraxinifolius*. In areas clear felled and kumried at Makut *Xylia xylocarpa* and cashew nut (*Anacardium occidentale*) have yielded the best results. As regards bamboo, sowing of seeds, cuttings and rhizomes were experimented with,—the first gave the best results.

24. *Hopea parviflora under shade*.—Out of 530 seedlings planted under shade 417 had survived. The percentage of success at the end of the year was 93, the plants are coming up well and some are about a foot in height.

25. *Frill girdling and poisoning with Sodium arsenite*.—In order to study the effect of girdling unwanted species as a substitute for improvement felling, a worked out coupe of 50 acres was selected and divided into 5 strips. In the first, all trees were girdled, and in the remaining 4 the trees were frill girdled and treated with sodium arsenite. The frill was about 2 inches deep and extended for about 12 inches down the bark of each tree. So far girdling seems to have had no effect. As regards poisoning, lower girth classes have been affected the most, the trees being dead in some cases while leaves are withering in others. Further results are being watched.

## MADRAS.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

In this brief report it is not possible to give full experimental data to support all statements made or opinions given nor does space permit mentioning all items of work undertaken. For fuller information the Annual Report on Silvicultural Research in the Madras Presidency for the year 1936-37 published separately should be consulted.

A large proportion of the work done has been small scale stage I (a) experiments in experimental gardens and routine seed germination and weighment tests.

The most important results obtained during the year are probably:—

- (a) Further demonstration of the necessity for *rab* regeneration in dry fuel forests. Apart from the mortality caused by man, grazing, fires, etc., the ordinary coppice felling causes about 7 per cent. of the stools to die each time the operation is done and preliminary counts show that natural regeneration is very scarce indeed and of the order of 3 seedlings per acre.
- (b) Improvement in district *rab* work particularly in the successful raising of forest crops in conjunction with field crops in dry fuel forest areas (such as *ragi* and castor in Madura district and cotton in Salem Central division).
- (c) Demonstration of the great benefits of soil working in the 1st year of *rab* regeneration in dry fuel forests.
- (d) Collection by experiment of statistics of teak stump production in nurseries and the methods by which economies can be made. In conjunction with this is the demonstration of the fact that in years of shortage, undersized stock in the nursery can be developed into good stock for the following year. These results are particularly important in view of the very poor seed year that occurred last year and the resulting shortage of stumps that followed.
- (e) Summary of 5 years experimental work at 3 centres in the premonsoon stump planting of teak.

- (f) Large scale confirmation by districts of experimental work in the premonsoon stump planting of teak and of the beneficial effect of using stumps of the best size.
- (g) The improvement of our knowledge of the regeneration and working of bamboos.
- (h) The continued success in the control of new outbreaks of the spike disease of sandal.
- (i) The summary by the Forest Entomologist, Dehra Dun, of the results of the investigation into the spike disease of sandal.
- (j) The further confirmation that *Lantana* can be controlled by chemical spraying and that this method is the cheapest method found so far.

### *Climate.*

Rainfall statements are given in the full annual research report.

### (ii) *Natural Regeneration.*

#### By Seed.

Experiments with *Hopea parviflora*, *Calophyllum elatum* and *Mesua ferrea* so far show that clearing undergrowth and raking the soil under mother trees are not beneficial in inducing natural regeneration. The indication is not conclusive as there have only been small seed falls since the experiments were started.

Canopy opening over young regeneration of *Hopea parviflora* was found to be very beneficial but produced no notable effect with *Mesua ferrea*.

Experiments have been started to endeavour to determine why at Nilambur some mature trees of *Swietenia macrophylla* have a dense mass of natural regeneration under them while other trees produce none.

Partial canopy removal over dense regeneration of *Pterocarpus santalinus* produced a very beneficial effect in spite of a year which was very unfavourable climatically.

#### By Coppice.

Experiments in the dry fuel forests of Chittoor district showed that the ordinary operation of coppicing causes a mortality of

approximately 7 per cent. of the stools and that trimming of the stools is definitely harmful in such areas.

Counts of natural regeneration in coupes in North Coimbatore division 5 years after the coppice felling showed that seedlings to the extent of only 3 per acre were present.

An experiment in the coppicing of *Mimusops hexandra* in the coastal forests of Tanjore showed that this species only coppices well in small sizes, that the mortality of stools increases rapidly with the girth of the stools and that even with the small sizes, mortality is high if the coppicing is done near to the ground level.

### (iii) Seed.

*Seed pretreatment.*—Routine pretreatment tests were done with 21 species. Treatment with boiling water improved the germinative capacity of *Acacia auriculiformis*, *Acacia cyanophylla* and *Acacia dealbata* but was harmful for nearly all other species tried. Soaking in cold water was beneficial with *Gluta travancorica*, *Pterocarpus santalinus* and *Xylia xylocarpa* being very marked in the case of the *Pterocarpus*. Concentrated Sulphuric Acid hastened and greatly improved the germination of *Cassia fistula* and *Cassia marginata* while fermenting greatly improved that of *Terminalia chebula*.

*Seasonal collection.*—Tests made with 10 species again showed no definite variations in germinative capacity throughout the fruiting season.

*Santalum album—peculiar variety.*—A sandal tree in North Salem division which is in a virulently spiked area and which has all the appearances of being spiked, fruited during the year. This tree has been under observation for 10 years and by grafting its tissue on healthy trees no disease can be induced. The seed was normal in germinative capacity and in weight and gave rise to seedlings some of which had healthy foliage and some spike like foliage. They are being kept under observation as they are possibly a variety of sandal immune to the disease.

*Seed storage.*—Routine tests were made with 24 species to determine the longevity of the seeds stored in different ways. Results are given in the full Annual Report.

*Seed weightments.*—Routine tests were carried out as usual. Results are given in the Annual Report.

*Sorting seed by size.*—Work done during the year confirmed previous years results that the sorting of teak seed by size is not justified economically.

Tests with seeds from small immature, normal mature, and large over mature seed bearers with 4 species showed no appreciable differences in germinative capacity or height growth of the resulting seedlings. Large scale Experimental Plots have been established to test the effects in later growth.

*Seed origin.*—Small scale experiments with teak seed of 6 origins have all showed comparatively little difference between the origins in early growth. We have 2 large scale long term Experimental Plots in this subject each now 3 years old. Sample plots will be laid out in each origin when the 1st thinnings become due.

#### (iv) Nursery Work.

In hot dry fuel areas shaded nursery beds gave generally a higher germinative capacity with nearly all the 20 species experimented with but in subsequent development and survival individual species exhibited different light requirements.

In evergreen nurseries, protection by sheltering from the very heavy rain of the south west monsoon resulted in a much higher percentage of survivals with *Artocarpus hirsuta*. In the hot weather, *Hopea parviflora* seedlings benefited by shade in the nursery while *Cedrela toona* seedlings did much better in the open.

An experiment on nursery watering in a dry fuel area showed that with these species watering should be very light until germination is over and should then be increased to give increased height growth and survivals.

Work on different nursery methods for raising teak stumps confirmed previous years results that the best outturn of good stumps is obtained by sowing seed at the rate of 20 to 30 lbs. per standard 40' x 4' bed and doing no pricking out of seedlings at all. A bed of this size in this way will produce after 1 year sufficient stumps of the right size to establish fully 1 acre of plantation at a 6' x 6' espacement and still leave a margin of safety.

Further experiments also showed that if owing to a poor seed year and consequent shortage of stumps, the undersized stumps have to be used, they are best put back into the nursery beds as stumps for a second year. At the end of the second year some 70 per cent. of them will have grown to the right size and they can then be stumped again and planted out. Results show that these stumps sprout as well as fresh stumps but their subsequent growth has yet to be determined.

Experiments to determine whether teak nursery beds deteriorate if they are used repeatedly and whether their fertility can be maintained by artificial or green manures have been started. Results so far show no deterioration in the 2nd year and an increase of 5 per cent. in the utilizable stumps produced in the beds manured with wood ash and leaf mould.

### (v) *Artificial Regeneration.*

#### (a) *Mixed deciduous timber forests.*

*Comparison of sowing, transplanting and stumping.*—Previous years results were confirmed and showed that for *teak*, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Artocarpus hirsuta* stump planting is the best of the 3 methods while for *Xylia xylocarpa* direct sowing is to be preferred. *Pterocarpus dalbergioides* and *Swietenia macrophylla* do best by transplanting.

*Optimum season for stump planting.*—Experiments were repeated for 5 species and in general confirmed previous years results. Last year was the 3rd consecutive bad year for early rains, the hot weather was unusually hot and in many places premonsoon showers were absent. The south west monsoon however broke about a fortnight earlier than usual. The result of this was that the best date of planting moved forward to April 1st but in many places the new sprouts could not last through the 2 months drought that followed and the most successful date of planting in consequence varied from April 1st to May 15th according to species and conditions.

Five years work in this subject has now been completed for teak in 3 centres and the results are summarised in the full Annual Report.

District work in 25 areas in 7 districts aggregating some 750 acres substantially confirmed the results of small scale experiments.

*Stump planting—Effect of age and diameter of stumps.*—Teak stumps of 0.4" to 0.8" diameter at the thickest part gave the best results though stumps of 0.3" to 0.4" diameter are definitely "usable" in the event of shortage of the larger stumps though they do not give as good results. The benefit of using stumps of the best size was demonstrated and confirmed by district work in the Wynaad division.

Work with *Dalbergia latifolia* again showed that 2-year old stumps are better than 1 year old stumps and 0.2" to 0.6" diameter

is the best range of size. For *Pterocarpus marsupium* results indicate that the larger stumps of 0.3" to 0.8" diameter (or even larger) give the best results. Results for *Terminalia crenulata* show 0.4" to 0.8" diameter to be the best size, and for *Artocarpus hirsuta* within the range experimented with, the bigger and older the stumps the better the results.

Experiments in burying teak stumps when planting them compared with normal planting showed no differences for normal 1st June planting but buried stumps were definitely better in the case of premonsoon (April 1st) planting.

*Storage of stumps—teak.*—Experiments again showed that stumps can be successfully stored for 2 weeks before planting even in an abnormally poor year climatically.

*Irrigated plantations—teak.*—Preliminary experiments in this subject show that irrigation by flooding (as in paddy cultivation) is more difficult and more expensive to do than irrigation by percolation from channels and gives no better results. Flooding also uses much more water.

Experiments have been started with *Swietenia macrophylla* to determine the best espacement and the best shade condition in which to grow the species. The season and incidence of its 2 great pests, the shoot borer and the collar borer are also being determined under these various conditions.

A number of experiments were done to determine the best method by which to regenerate *Bambusa arundinacea* and *Dendrocalamus strictus*. Further work is needed before definite results can be confirmed.

*Casualty replacements in 2nd year teak plantations.*—Observations of current experiments in this subject were continued. Results indicate that few of these replacements survive and it is doubtful if they ever take their place in the main crop.

*Effect of taungya (ponam) crops on teak plantations.*—Previous work was repeated and shows that *ragi* (*Eleusine coracana*) retards the height growth of the teak by 40 per cent. in the first year while *dhall* (*Cajanus indicus*) has very little effect. This retarding effect of the *taungya* crop can be greatly reduced by early planting the teak.

### (b) Evergreen rain forests.

All artificial regeneration work in evergreen forests (with the exception of experiments on raising evergreens after clear felling

and burning) comes under the category of underplanting and is therefore dealt with under that head.

(c) Dry fuel forests.

Artificial regeneration of dry fuel forests by the *rab* method is being done on a larger scale each year in almost all divisions where this type of forest occurs and results are getting more and more encouraging as the technique improves.

The greatest advance of the last few years is in the raising of these dry fuel species in conjunction with field crops such as *ragi* (*Eleusine coracana*), castor (*Ricinus communis*) and cotton (*Gossypium barbadense*). A detailed description of this work is given in the full Annual Report.

Results of experimental and district *rab* work show that regeneration is best raised by direct sowing with most species. The best date of sowing varies greatly each year and the most practical method found is to sow early and to go on resowing at reasonable intervals until full stocking is obtained. (Seed is generally plentiful and cheap.) Transplanting and stump planting are in general not suitable to these species in this type of area.

The following species have given excellent results:—*Cassia siamea*, *Albizzia lebbek*, *Azadirachta indica*, *Dolichandrone crista*, *Acacia sundra*, *Albizzia odoratissima*, *Pterocarpus santalinus*, *Albizzia amara*, *Wrightia tinctoria*, *Zizyphus jujuba*, *Pithecolobium dulce*, *Acacia ferruginea*, *Prosopis juliflora*, *Tamarindus indica*, *Acacia planifrons*, *Acacia arabica*, *Pongamia glabra* and *Cleistanthus collinus*.

A good burn coupled with soil preparation before sowing is essential for this work.

Soil working during the 1st year is very beneficial. It not only produces a much increased height growth but also enables backward plants to survive the hot weather.

A successful start has been made in the raising of plantation to be worked for manure leaves by the planting of large shoot cuttings of *Poinciana elata*.

Stump planting of *Santalum album* has given a large measure of success and it has also been demonstrated that sandal stumps can be kept in air-tight tins without deterioration for 3 weeks before planting.

Detailed experiments were also done on the influence of host plants on the seeding of sandal, and the extent of and the necessity

for parasitism of this species. It is to be noted that results show that even though growing in close proximity to many species sandal usually only parasitises freely on a few particular species.

(vi) *Afforestation.*

Experiments to examine the possibility of re-afforesting some of the more important catchment areas of the Nilgiris were continued and so far have given the following general indications:—

- (a) The moister localities can be easily stocked with willows by cuttings. They are frost hardy but need protection from browsing.
- (b) Small, close planted, concentrated plots do better than large areas of open planting owing to more efficient frost protection being possible.
- (c) Frost protection is best done by means of a complete pandal about 1' 6" from the ground and screened on the up hill side.
- (d) Nurse species can be raised as follows:—
  - (i) Broom, *Dodonea viscosa*, *Cassia tomentosa* by sowings.
  - (ii) *Buddleia* spp. by cuttings.
  - (iii) *Ligustrum neilgherrense*, *Rubus moluccanus*, *Rubus lasiocarpus*, *Myrsine wightii* and *Hypericum mysorensense* by planting stumps got from the forest.
- (e) Tree species can be raised as follows:—
  - (i) *Acacia dealbata* by 2 years old large transplants.
  - (ii) *Cupressus macrocarpa* and *Callitris rhomboidea* by small transplants and these can come from the forest if necessary.
  - (iii) *Acacia melanoxylon* and *Eugenia arnottiana* by mossed transplants.
  - (iv) *Mahonia leschenaultii* by stumps and these can come from the forest.

(vii) *Tending, Thinning, Cleaning, etc.*

*Weeding practice.*—Large scale experiments were done in continuation of the work of the past few years and results again conclusively confirm previous years' results that the slightly beneficial effect (if any) of forking as opposed to mamooty scraping as a weeding method in the first 2 years of a teak plantation in our better teak areas is in no way commensurate with the extra cost

of forking. The saving by mamootty weeding instead of forking is approximately Rs. 3 to Rs. 5 per acre each time the operation is done and when this is totalled for the main teak districts of the Presidency it is an annual saving of a considerable sum of money.

These experiments were all done in areas with a naturally light friable soil and a rainfall of 60" to 120" per annum. The effect of forking in dry fuel forests has already been noted on page 67.

*Effect of a cover crop of Leucaena glauca on a teak plantation.*—In an experiment in this subject the teak with the cover crop showed an increased height growth over that of the control teak at the end of the 1st year but this increase had greatly diminished by the end of the 2nd year. The *Leucaena* was continually browsed by deer and bison and was no use at all as a weed suppressor.

*Thinning research—teak.*—All plots in this subject were maintained but there is nothing of particular interest to report.

*Bamboos.*—Experiments on the intensive tending and working of bamboos were continued and showed that such intensive work is economically justified by the improvement in the condition and yield of the clumps and the increased revenue obtained.

#### (viii) *Mixtures.*

Nil.

#### (ix) *Underplanting.*

(a) *Teak plantations.*—All plots were maintained but no new work was undertaken. Experience so far indicates that teak plantations can be successfully underplanted with *Bambusa arundinacea*, *Cephalostachyum pergracile* and *Hopea parviflora*. *Swietenia macrophylla* and *Cedrela toona* although established suffer a great deal from browsing and bark stripping by deer.

(b) *Evergreen rain forests.*—Experiments in the regeneration of evergreens with and without a cover crop after clear felling and burning evergreen forest have been started and show promise. Most of the work of the past few years has been in underplanting under various degrees of canopy. General results are:—

- (i) Top canopy cover gives the best results.
- (ii) Burning before regeneration produces no beneficial results.
- (iii) For most species transplanting is the best method and some of the tenderer species do well if mossed or basketed.

- (iv) Stump planting is not a suitable method for most ever-greens. The exceptions to this are *Artocarpus hirsuta*, *Cedrela toona* and *Chickrassia tabularis*.
- (v) Weeding is worth while as it gives a slight gain in height growth and survival percentage.
- (vi) Pitting for planting is also similarly worth while although the effects of pitting do not show until the second year when the roots and their needs have both got bigger.
- (vii) The best date of transplanting for most species is mid June or early August, *i.e.*, either just before or just after the heaviest rain of the south west monsoon.
- (viii) For most species the best size of transplant to use is from 8" to 1' high. Larger transplants occasionally do well but suffer heavy casualties and are not definitely established for several years. In the case of large transplants of *Cedrela toona* and *Swietenia macrophylla* insect attack is more serious than with small plants.

(x) *Silvicultural Systems.*

Nil.

(xi) *Miscellaneous.*

*Sandal Spike Disease Research.*—Details of work carried out during the year cannot be given in such a brief report as this. The Forest Entomologist, Dehra Dun, inspected the work during the year and summarized results so far obtained as follows:—

- (i) Spike is an insect borne disease.
- (ii) The disease is excluded from a plant by barriers of cloth and of wire gauze of 20 meshes to the inch; it is not excluded by wire netting of 2 meshes to the inch.
- (iii) Small wind borne insects penetrate 20 mesh wire gauze and hence are unlikely to be vectors.
- (iv) The vector passes an aperture of half an inch, hence many large bodied and long legged species are unlikely to be vectors.
- (v) The vector frequents sandal foliage during the period dusk to dawn.
- (vi) The vector is probably either (A) an uncommon species or (B) an uncommon strain of a common species.
- (vii) The vector is active as a transmitting agent at two seasons of the year, February to May and July to December

but population surveys show that the incidence of sandal sap-suckers falls very low in June.

- (viii) Artificial transmission experiments have failed to produce spike but suspicious conditions have been produced by *Moonia* and by *Lantana aphids*.
- (ix) The common factors in these experiments were either (a) confinement with spiked plants and immediately after with healthy plants, or (b) confinement with spiked plants and immediately after with spiked and healthy plants and a long period of exposure. There was considerable variation in the nature and size of cage and in pruning or other after treatment.
- (x) Spike has been produced in 2 cases in large cages by releasing wild insects directly after collection.
- (xi) An exposure of one month is sufficient to permit infection.

Anti-spike operations carried out indicate that such control measures are fully effective in the case of areas where only a few trees are found infected and that in the case of large blocks of forest where the disease has been allowed to spread for some years uncontrolled, the effect of the control operations is to confine the disease to the original limits of the outbreak.

*Periodicity of height growth.*—Weekly measurements showed that in deciduous forest the general rest period was from the middle of November to the middle of April. In evergreen forest and in dry fuel forest most species grow slowly but steadily all through the year.

*Weeds—Lantana eradication.*—Experiments in the suppression of *Lantana* by underplanting it with *Bambusa arundinacea* were extended and continue to look promising.

Large scale experiments in destroying this pest by spraying with a sodium chlorate spray show that the method is the most successful and least expensive of any method so far tried.

*Climber poisoning.*—Experiments were continued and show that most of the common species of climbers can be successfully eradicated at a reasonable cost by means of an arsenical poison.

Experiments on the suppression of *Eupatorium* by means of *kikiyu* grass (*Pennisetum clandestinum*) were extended and continue to look promising. This work is most important in the reclamation of grazing areas which have been invaded by the pest.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

Five working plans were under preparation at the beginning of the year and 3 were completed during the year. 3 new plans were started during the year.

The cost of preparation, inclusive of establishment, was Re. 0-6-6 per acre.

### (ii) *Yield, volume and form factor tables.*

During the year 10 sample plots were handed over to the new Orissa Province and 68 sample plots, 21 tree increment plots and 18 preservation plots were maintained.

## III.—MISCELLANEOUS.

### (i) *Tours.*

In accordance with item 1 (a)-(c) of Resolution No. 3 of the Dehra Dun Silvicultural Conference held in 1934 and under the sanction of the Government of Madras, the Provincial Silviculturist toured in East Bengal in November/December 1936 to study the regeneration of mahogany and evergreens. This tour was very instructive and of the greatest use.

The sandal spike research works in North Salem division were inspected by the Forest Entomologist, Dehra Dun, during the year who kindly summarised the work done so far and made valuable suggestions for future work.

The Provincial Silviculturist toured for 201 days during the year.

### (ii) *Records.*

The Specific and General Ledger Files now number 429 and 152 respectively.

Seventeen new Experimental Plots and 254 new Experimental Garden experiments were opened during the year while 13 Experimental Plots and 112 Experimental Garden experiments were summarised and closed during the year. At the end of the year 76 Experimental Plots and 287 Experimental Garden experiments were open.

Twentythree photographs were added to the collection during the year.

*Staff.*

The Extra Assistant Conservator of Forests remained in the division throughout the year as assistant. The subordinate staff now consists of 3 Research Rangers, 9 Foresters, and 1 Forest Guard.

During the year all arrears of office work and of the experimental records of the field work were cleared off and the office was up to date at the close of the year.

**NORTH-WEST FRONTIER PROVINCE.****I.—EXPERIMENTAL SILVICULTURE.***(i) General.*

The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*) in forests worked under the uniform system, particularly in the Galis division, where two long periods of drought, i.e., from the beginning of May till the breaking of the monsoon in July, and again from the end of September till about Christmas, make it extremely difficult for the seedlings which germinate early in the monsoon to establish themselves.

*(ii) Natural Regeneration.*

The sample plots laid down to ascertain the most suitable intensity for a seeding felling in blue pine forests have given no definite results, but as mentioned above the main problem is not to get the seedlings on the ground, but to carry them on over the first few years of their existence.

Young growth already on the ground appears to belong to definite years with wide gaps in between and an investigation has been started to correlate the age of these seedlings with the rainfall statistics of the period following germination.

More investigation is necessary into the cause of death and arrangements are being made with the Punjab Research Division to lay down observation plots for both blue pine and silver fir, on both limestone and shale.

*(iii) Seed.*

The year 1936 was a very bad seed year for deodar, but a good one for blue pine and chir. 19 mds. 20 srs. of chir seed were sent to the Forest Botanist for supply to the South African Forest Department.

What had become almost a tradition, that Kagan deodar was of poor quality and that for artificial work in other places it was necessary to obtain seed from Kashmir, has now been definitely disproved, as large quantities of Kagan seed used in December 1935 to undersow a blue pine regeneration area in Panjul 7 (i) have given remarkably good results. Germination was profuse and by the end of the season the average height of the seedlings was 10 inches and some were 15 inches high.

#### (iv) *Nursery Work.*

In addition to the ordinary nurseries, maintained in the hill divisions, for re-stocking the areas felled over, a large nursery is maintained at Nowshera, and others at Cherat, Parachinar, and Malakand in the Peshawar division, for the supply of plants required for station planting and the re-planting of canal banks. A large nursery is also maintained at Razmak for the supply of fruit and garden plants, and despite the unsettled conditions of Waziristan, no less than 10,000 plants were distributed during the year.

#### (v) *Artificial Regeneration.*

*Cedrus deodara*.—Patch sowings of deodar continue to give the best results, particularly on patches where debris has been burnt. Planting is less successful, but in many cases this is due either to the use of undeveloped plants, or to planting at too high an elevation. Although doubts have been expressed regarding the advisability of continuing to introduce deodar into the Gali forests, there is no reason why it should not succeed provided work is confined to suitable elevations, not higher than 7,000 feet.

In Upper Siran it was found that sowings of deodar, made in April and May, immediately after the snow had melted, gave just as good results as sowings made in November and December.

*Pinus longifolia*.—During the last four years, chir plants raised in tin tubes have been successfully planted in the Cherat Cantonment and Malakand Agency forests, showing that this method can be usefully employed, where the locality factors are particularly difficult.

*Pinus gerardiana*.—This species has been successfully raised in the nursery at Narang in Upper Kagan, but sowings made in the forests have failed.

*Nannorhops ritchieana*.—Experiments made with the dwarf palm, a plant of great economic importance in the Kohat district,

have shown that, where irrigation is not available, it is almost impossible to grow this species either by planting of offsets or by sowing. With irrigation, however, it can be easily raised by sowing on the berms of trenches.

*Acacia modesta* and *Dodonaea viscosa*.—Experiments on the propagation of these two species, both in Cherat Cantonment and the Khawara reserved forest have shown that the best method is to sow in interrupted horizontal trenches. Germination is profuse immediately after the break of the monsoon, but the seedlings die off if there is more than ten days break in the monsoon. Some of the seed usually does not germinate until the winter rains, but in that case the seedlings never survive the hot weather.

*Exotics*.—Experiments are being continued to discover suitable exotics for introduction into the low hills of the Frontier. During the past four years some 4,000 plants of *Ailanthus glandulosa*, *Grevillea robusta*, *Maclura aurantiaca* (the Osage Orange), *Schinus molle*, *Eucalyptus rostrata* and *Robinia pseud-acacia*, raised in pots and tin tubes have been successfully planted and established with the aid of watering in the Cherat Cantonment, at an elevation of 4,000 feet, where both the soil and climatic conditions are extremely unfavourable. *Ailanthus glandulosa* has also been successfully introduced at elevations up to nearly 8,000 feet in the Galis division. *Pinus pinea*, *Pinus halpenensis*, and *Pinus caribea* have also been raised in tin tubes in nurseries, but have not yet been planted out. At Parachinar experiments to discover a species of eucalyptus which will survive the winter show that *Eucalyptus globulus* is by far the best species.

#### (xi) *Miscellaneous*.

*Grazing*.—Further experiments were carried out in the Kagan division to study the effects of closure on both chir (*Pinus longifolia*) and blue pine (*Pinus excelsa*) regeneration.

In the case of chir, a grazing incidence of 6 acres per head of cattle has been found useful, as it keeps down the growth of grass, to the benefit of the seedlings.

With blue pine it has been found that grazing in regeneration areas is dangerous during the summer months (May and June), but once the monsoon has broken an incidence of 10 acres per head is beneficial.

Even in blue pine forests burdened with grazing rights, with an incidence of about 8-10 acres per head, it has been found possible to introduce deodar by sowing. Although the cattle

appear to prefer deodar to blue pine seedlings and damage is caused by trampling, sufficient deodar seedlings generally survive to form a mixture with the pine.

*Eradication of raspberry canes.*—Up-rooting and burning appears to be the only effective method of getting rid of this weed, which gives considerable trouble in some of the blue pine regeneration areas. The cost of this operation is, however, high, about Rs. 25 per acre.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working plans.*

The revision of the Galis working plan was commenced and it has been decided that the uniform system of management should be abandoned and a return made to the selection system. The yield will be calculated from a complete enumeration of all conifers 12" in diameter and over, standing in the area allotted to the selection working circle.

### (ii) *Yield, volume and form factor tables.*

The chir and blue pine sample plots, originally laid down by the Forest Research Institute, were maintained by the Punjab Silvicultural Research division, to whom they have been transferred.

Statistical data for standard and commercial volumes from one deodar and nine blue pine trees in the Kagan forests were sent to the Punjab Silvicultural Research division.

## ORISSA.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

With the formation of the new Orissa Circle Mr. J. W. Nicholson, I.F.S., originally appointed as Research and Working Plans Officer had also to officiate as Conservator of Forests, and carried out the duties of both posts. Pressure of administrative duties, and the lack of an organised research staff, necessitated the postponement of the compilation of a programme of silvicultural research for the new Province. During the year it was possible to do little new work, but all work in connection with sample and experimental plots was brought up to date.

As only one officer will be available in future for both research and working plans work, Orissa will have to restrict silvicultural research work to really important problems, and the following statement shows the numbers of Experimental Plots existing in each division :—

Division.	No. of plots existing on 1st April 1936.	Abandoned during the year.	New plots laid out during the year.	Total No. at the close of the year.
Angul . . . . .	25	13	1	13
Puri . . . . .	25	10	—	15
Sambalpur . . . . .	6	5	—	1
Barapahar . . . . .	2	—	—	2
Ganjam . . . . .	35	—	—	35

(ii) *Natural Regeneration.*

*Sal.*—The most important problem to be solved is re-obtaining sal regeneration in the *mals* forest of Puri division where fire protection has induced an evergreen invasion. The first experimental plots in this area were laid out in 1924. Since then other plots with new and improved technique have been added. No plots have as yet given definite results. The treatment of the oldest plots has been altered from time to time. Progress in the establishment of sal regeneration has been very slow, due largely to the fact that most of the mature seed bearers were felled when regeneration felling took place in P. B. I. The indications are that annual hurning over a period of many years helps to induce invasion of grasses and reduction of evergreen species. It is not possible to burn the plots in a wet year, and as stoppage of burning operations, even for one year, helps evergreen growth to recover its vigour, the few plots, where biennial burning was prescribed, are not of much value. Other plots prescribed hoeing,—an operation which could not be carried out on a field scale. It was felt that the only practicable lines of attack were annual hurning, annual shrub cutting, or a combination of hurning and shrub cutting. As good burning is not practicable in the case of small plots, the whole forest in which the plots are situated will, in future, be burnt, except control plots due to be fire-protected.

Consequent upon the indications given by the sal regeneration plots a change was made in the burning prescriptions of the sal selection working circle. Hitherto, the area has been mainly under fire protection and the aim has been to concentrate cleanings on existing sal saplings. Owing to the evergreen growth, repeated

and expensive cleanings are required, and in the end a very incomplete sal pole crop will result. It was decided that a sounder policy would be to carry out a systematic programme of burning over a period of several years with the object of killing out most evergreen growth, and inducing conditions favourable to the establishment of sal regeneration. Once those conditions are obtained the area can be temporarily fire-protected, and cleanings carried out. In future, therefore, both in the old P. B. I. area and in the selection felling coupes, burning will be the usual procedure.

Four plots, laid out in 1925 and 1926 (now closed down) in Sambalpur division, to test the effect of burning after felling on coppice regeneration did not shew any significant difference in growth.

Certain plots, established in 1924 and 1925 in Angul division, to test the effect of burning on the establishment of sal regeneration in dry to damp types of sal forest have shown that establishment of natural regeneration has been adversely affected by late fires in the dry type where early burning will be done from now onwards.

*Casuarina*.—The experiments in layering casuarina tree branches have not yet given definite results.

*Teak*.—There are no teak plantations older than 50 years in the Circle, and hitherto the question of obtaining natural regeneration has not received attention. A bad cyclone in Puri division in October 1936 caused havoc in certain old plantations. It is now considered advisable to take steps to induce teak regeneration in middle aged crops. Divisional experiments carried out in the Puri *mals* indicate that by opening out 50 per cent. of the canopy, removing the undergrowth, and burning the debris, natural regeneration of teak is assisted.

### (iii) *Seed.*

Nothing of importance to record.

### (iv) *Nursery Work.*

The *dona* system of raising nursery seedlings (as a provision against shortage of stumps) was tried in Angul and Sambalpur divisions with yet indefinite results. Experiments are also in progress to ascertain the best technique for raising teak stumps of the optimum size within one year.

### (v) *Artificial regeneration.*

*Rab* sowings on Madras lines were tried in Ganjam and Barapahar divisions with teak, babul (*Acacia arabica*) and *Cassia*

*siamea* in coppice coupes of a dry evergreen thorn forest type of the former (Ganjam) and with *Terminalia arjuna*, *Terminalia tomentosa*, *Gmelina arborea*, *Dalbergia latifolia*, and *Pterocarpus marsupium* in a blank area on dry poor soil in the latter (Barapahar). The results obtained so far indicate that rab sowings offer a promising solution to the problem of stocking small blanks or introducing more valuable species in these and other divisions.

Planting of *Aleurites fordii* was tried in Puri division with poor results.

#### (vi) *Reclamation and afforestation.*

The re-afforestation of dry poor soils presents a difficult problem, and all previous attempts to introduce important tree species had failed,—including cuttings of even uneconomic tree species such as *Banyan*, *Boswellia serrata*. Cuttings of the shrubs like *Dodonea viscosa*, *Vitex negundo*, and *Ixora parviflora* have, however, given fair results.

Of the various broad leaved species introduced in the Puri *Cosuarina* plantation in past years, only *poonang* (*Calophyllum inophyllum*) and the *cashew* nut have succeeded,—the former only under shade. In 1936 the rain tree (*Enterolobium saman*) was tried and the survival percentage up to date is 92. Natural regeneration of *Odina wodier* and *Melaleuca leucadendron* is taking place in the plantation.

Anti-erosion experiments were initiated in Ganjam division in plains sal forests.

#### (vii) *Mixtures.*

Nil.

#### (viii) *Tending.*

As a result of a series of field experiments, the revised thinning rules for mixed coppice coupes which were published in the *Indian Forester* aim at increasing the proportion of valuable species and at thinning out the latter where necessary. No thinnings are done amongst inferior species, except where necessary to give room to principal species.

In the clear felled sal coupes of Ganjam division creeper cutting is done in one year old coupes where the commonest pestilential creeper is *Mucuna pruriens*. The cutting and removal of these creepers causes damage to the leading shoots of sal.

Experiments have just been initiated to test if, instead of cutting these annuals (*Mucuna*), uprooting the perennial creepers at the beginning of the second rains would let the sal crop grow just as well.

Experiments started in Puri division in 1924 to test the effect of pollarding, pruning, and coppicing *kuchila* (*Strychnos nux-vomica*) trees on their fruit production were concluded with the result that no such artificial methods of stimulating fruit production have proved successful,—the untouched control plot having given the best results.

#### (ix) *Underplanting.*

Underplanting of teak stumps in a forest containing *Bambusa arundinacea* clumps was tried in Angul with poor results,—the shade being too dense.

#### (x) *Silvicultural Systems.*

The Palamau system of carrying out coppice fellings was introduced experimentally in some felling series in Sambalpur division, and it was also decided to try it in Ganjam division. Under this system clear felling is not enforced. Only marketable trees are removed by the contractor. All unmarketable promising saplings or poles of principal species are left to form part of the future crop; unpromising stems of principal species are cut back; and miscellaneous species interfering with the growth of principal species are cut back or girdled. The system should succeed well whenever market conditions do not admit of complete conversion. It avoids waste of promising saplings and poles; saves expenditure on unnecessary coppicing; reduces exposure of the soil; and by reducing grass growth, minimises risks from fire.

The older set of experimental plots on *Dendrocalamus strictus*, laid out in Sambalpur in 1924, were initiated through faulty technique or maintenance and, therefore, closed down as inconclusive. These, however, have given some indications, viz., (i) where fellings were done on a 3-year rotation leaving new shoots along with 7 old shoots, the yield of culms was just as great as in the control where no fellings were done; and (ii) under a clear felling system, 7 years is an insufficient felling cycle to produce culms of the original size.

A series of 5 plots established in 1929 to determine the best methods of cutting *Bambusa arundinacea* were also closed down as results have been vitiated by faulty maintenance of records. Interim results indicated that (i) felling of half the clump on a

3-year rotation proved too drastic for the clear felled halves to yield any new culms and (ii) under a clear-felling system of working, a rotation of 10 years was required to produce full sized culm.

(xi) *Miscellaneous.*

*Dying of Casuarina.*—For the last 3 or 4 years there has been considerable speculation over the causes of dying back of *Casuarina* trees over extensive areas in the Puri plantation. Originally it was imputed to water logging. Later, a theory was advanced that the water level had fallen owing to the construction of a drainage canal. Those which had died had never developed taproots but had a horizontal spreading root system. Just after the drainage canal was made, small vertical roots were sent down from the horizontal root system. The living trees within the area affected are all on higher ground and they possess one or more main taproots. It seems clear that in the failed areas the water level was originally very close to the surface, but on the water level falling, the later vertical roots sent down were unable to supply sufficient water to the tree system.

*Contour trenching.*—Contour trenching experiments initiated in 1935 in Angul division have given no results of value.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

A working plan for the private forests of Dalijora estate, which have been taken under Government management, was prepared, but was not finally approved of.

Certain amendments to the Ganjam, Puri, Sambalpur and Barapahar working plans were made. Planting of teak and *Gmelina arborea* was laid down in the plan for the Ravine Working Circle. In Sambalpur and Barapahar plans burning prescriptions were altered to admit of early burning operations being more extensively carried out. Changes were also made in marking rules and cleaning prescriptions, and the rules for marking standards radically altered. The so-called menace of bamboos to regeneration of tree species had been grossly magnified. In the early years after coppicing bamboos do appear to suppress tree species, but the latter usually push their way through in the long run, and then it is the bamboos that tend to become suppressed. It was decided that the best way of dealing with the bamboo menace was to restrict cutting of young culms to coppice coupes due to be worked

1 to 3 years hence. This should result in bamboo clumps having diminished in vigour at the time of coppicing.

(ii) *Yield, Volume, and Form Factor Tables.*

The number of existing Sample Plots is as follows:—

Division.	No. of plots existing on 1st April 1936.	Abandoned during the year.	New plots laid out during the year.	Total No. at the close of the year.
Angul . . .	13	—	—	13
Puri . . .	60	5	—	55
Sambalpur . . .	20	—	—	20
Barapahar . . .	11	—	—	11
Ganjam . . .	10	—	—	10
Total . . .	114	5	—	109

The 5 plots abandoned in Puri division represent teak plots in which nearly all standing trees were blown down by a cyclone in October 1936.

During the year interim measurements were carried out in 7 and full measurements in 18 plots.

Volume data for 100 trees of *Terminalia tomentosa* were collected in Angul division.

## PUNJAB.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

(a) *Propagation of Prosopis juliflora.*—Pods were collected from known parent trees of different forms in Lahore and of Mexican form in Delhi. The total collection was 23 maunds. Of this  $9\frac{1}{2}$  maunds pods were from trees of Mexican form, about 10 maunds of Australian and the balance of other forms. About  $18\frac{1}{2}$  maunds of pods were issued to divisions and other Government departments;  $8\frac{1}{2}$  maunds of this were of Mexican form.

12,000 pot plants (11,000 of Mexican and 1,000 of Peruvian form) were raised at Lahore for distribution. Planting was done over selected mile lengths along the railway line near Shahdara, Karnal, Ferozepur and Khanewal, and also close to gang huts in various railway sections. Over 50 per cent. of these plants are established.

(b) *Treatment of railway embankment at Jhelum.*—The object of this experiment was to stabilise the very steep sandy banks of the newly raised bridge embankment by getting suitable plants to grow on it. About 1,200' × 20' sloping embankment face was revetted; grass cables were embedded 3' apart along the contours, and wattling completed with rows of dry wooden stakes alternating with live cuttings of *Ipomoea carnea*, 3' apart. 12,000 *Agaves* were planted centrally between the rows. The demonstration has proved convincing to the railway authorities.

(c) *Planting in the mela area in Kurakshetra.*—250 plants were planted for shade and ornament in the mela area. The species used were *Azadirachta indica*, *Bischoffia javanica*, *Celtis australis*, *Ficus benjamina*, *Kigelia pinnata*, *Melia azedarach*, *Millettia ovalifolia*, *Pistacia integerrima*, *Poinciana regia*, *Pongamia glabra*, *Pterospermum acerifolium*, *Salix tetrasperma*, *Tecoma stans*, *Terminalia arjuna*.

#### (ii) *Natural Regeneration.*

*Cedrus deodara.*—Natural regeneration was abundant in the regeneration areas (Kulu and Seraj). In the deodar crops of the dry zone burnt by the 1921 fires, natural seedlings have appeared under the shelter of mother trees, but in blanks and exposed places only *kail* (*Pinus excelsa*) seedlings (Upper Bashahr).

*Pinus excelsa.*—Natural seedlings were noticed in abundance in regeneration areas, fire blanks dating from 1921, and other places despite grazing. Young plants of *kail* were cut down wherever they interfered with deodar seedlings (Seraj).

*Pinus longifolia.*—Natural regeneration was abundant in the regeneration areas (Seraj). In the experimental plots in unregulated *chil* forests, C. 18 Bhangal (Rawalpindi East), closure to grazing made no significant difference on the influx of natural regeneration.

*Picea morinda* and *Abies pindrow.*—Natural regeneration was good in Seraj division; a quantity of it was noticed in the upper part of Bajrundi (Kulu). In the Lower Bashahr experimental plots, regeneration was found in well drained situations where humus and weeds were not excessive. In the Kulu plots (Research), observations showed that under hardwoods, seedlings were more numerous below unlopped than lopped trees; more numerous in 50' wide than in 75'–100' wide clear-felled strips, and more in 20' × 30' than larger gaps; also that soil working of some kind is essential, e.g., scraping off humus and exposing the

mineral soil was more effective than working up the humus with the soil, though both gave better results than undisturbed humus.

*Pinus gerardiana*.—Natural seedlings preferred sheltered situations, and were observed under the shelter of rocks, stones, etc. (Upper Bashahr).

*Dalbergia sissoo*.—In the riverain areas (Depôt West), natural regeneration came up profusely, but was wiped out by grazing except in places where bushes provided the necessary protection; prolonged submergence of seedlings under water was also an injurious factor (Depôt West). Regeneration from root suckers was abundant in trenched areas (Depôt West); trenching up to a distance of 1 chain from the mother trees resulted in abundant regeneration from root suckers in Phillaur, and proved helpful in increasing the proportion of *shisham* in the mixed crops (Upper Bashahr).

*Morus alba*.—In the riverain areas, natural regeneration was abundant under *shisham* crops as well as in non *shisham* bearing areas, but seedlings were destroyed by grazing; in Thatta Faqirulla R. F. much damage was done by *nilgais* (Depôt West).

### (iii) Investigation on Seeds.

#### (a) Seed years—

*Abies pindrow*.—Poor (Seraj, Lower Bashahr) moderately good (Kulu), good (Simla).

*Acacia arabica*.—Good (Depôt West).

*Acacia catechu*.—Good (Rawalpindi East).

*Acacia farnesiana*.—Good (Depôt West).

*Acacia modesta*.—Good (Rawalpindi East).

*Cedrus deodara*.—Poor (Kulu, Seraj), moderately good (Lower Bashahr).

*Dalbergia sissoo*.—Good (Depôt West).

*Olea cuspidata*.—Good (Rawalpindi East).

*Picea morinda*.—Poor (Kulu, Seraj, Lower Bashahr), good (Simla).

*Pinus excelsa*.—Poor (Kulu), moderately good (Seraj, Lower Bashahr, Rawalpindi East).

*Pinus longifolia*.—Poor (Kulu, Seraj, Lower Bashahr), good (Rawalpindi East).

*Prosopis glandulosa*.—Good (Depôt West).

*Prosopis juliflora*—

Australian form.—Very good (Research).

Mexican form.—Good at Lahore, poor in Delhi (Research).

Arid form.—Poor (Research).

Argentine form.—Poor (Research).

Peruvian form.—Moderate (Research).

(h) *Seed storage*.—Calcium carbide was found very effective in preventing injury to *Prosopis juliflora* pods by *Caryoborus gonagra*, which attacks them readily under storage conditions. A few lumps of calcium carbide placed amongst the pods before sealing the tins were sufficient to check the attack (Research).

(iv) *Investigation on Seedlings.*

(a) *Seasonal height growth*.—Measurements of height growth were recorded in research nurseries, the incidence of maximum monthly increment was in July for *Casuarina cunninghamiana*, *Eucalyptus rudis*, *Maclura aurantiaca*, *Prosopis juliflora* (Argentine form); in August for *Casuarina lepidophloia* and *Eucalyptus rostrata*; in October for *Acacia arabica*, delayed probably on account of the previous winter's frost damage (Research).

(b) *Frost injury*.—The progeny of Mexican and arid forms of *Prosopis juliflora* raised at Chichawatni and Samhalpani from pods collected from known parent trees of undisputed identification did not prove frost hardy. At Chichawatni the lowest temperature recorded was 28°F. (Research).

(v) *Investigations on Trees and Crops.*

(a) *Phenological Observations*.—Observations were recorded for selected species (Research).

(b) *Water requirements of shisham crops*.—Experiments to determine the depth and frequency of irrigations required for shisham crops were continued in Daphar.

(c) *Inheritance of characters*.—For shisham, experiments were continued to investigate the inheritance of characters of stem (crooked, forked and straight), leaf size, and time of leaf shedding.

(vi) *Artificial Regeneration.*

*Cedrus deodara*.—Sowings were carried out over 30 acres (Seraj). In the dry zone, sowings were done under the shelter of stones and in patches protected against the hot sun by means of wooden chips and stones erected round them; results with the

latter method are promising (Upper Bashahr). Sowings failed in Kamra C. 5 and Prindla C. 9 (Rawalpindi East). Planting  $4\frac{1}{2}$  year old seedlings gave good results (Seraj); in the dry zone, winter planting was tried (Upper Bashahr). Over 63,000 seedlings were planted in Kulu, including the restocking of Nagni and Niaragarh areas destroyed by the 1921 fires.

*Abies pindrow* and *Picea morinda*.—Planting was successful in Seraj; and also in the Lower Bashahr experimental plots, but costs did not justify large scale operations (Lower Bashahr).

*Pinus longifolia*.—In C. 85 Jawaud R. F. sowings gave only about 30 per cent. success over 4 acres overgrown with brushwood; growth was cut before sowing and the area fenced; in Guha, only 2 per cent. seedlings of sowings survived in the 2 acres open to grazing as against 20 per cent. in the closed one (Rawalpindi West). Sowings failed in experimental plots (Jhelum).

*Dalbergia sissoo*.—L-cuttings (stumps made from root suckers) were very successful; 27,000 were used locally in the plantations and 28,000 supplied to local bodies and various Government departments (Montgomery). Stumps failed in Jhila Cherah, plants being killed by hares and white ants (Rawalpindi East). In the riverain areas, planting at the right time was very important; planting too late in Bela Sahjowal and too early in Bela Jokalian failed. Stumps were successful in Thatta Faqirullah on stiff clay, and in Bela Nurpur Piran (Depôt West). Under a *Eucalyptus* overwood at Changa Manga the growth of *shisham* maintained as an understorey was retarded by the *Eucalyptus* (Tramways).

*Morus alba* and *Melia azedarach*.— $1\frac{1}{2}$  million seedlings were handled in planting operations. In new areas 50 plants per acre were introduced to obtain a mixture; in older crops underplanting was done after the first or second thinning over 2,400 acres (Multan). In Daphar, planting mulberry cuttings after the first rains in areas already stocked with previously planted *shisham* cuttings was found economical (Lahore). All available data on the cultivation of the mulberry has been summarised by Mr. I. D. Mahendru and published as Punjab Forest Records No. 2 (Research).

*Agave species*.—Plants are well established in areas under erosion in Kangra and have appreciably reduced erosion intensity. Bulbils are much more tender than root suckers, which proved exceedingly hardy even after a long journey and considerable exposure. Bulbils should be kept in nursery lines at least a year before being used as transplants (Research). In Jhelum success

was about 50 per cent. in the Chakwal. In Pahhi planting has been done with 70 per cent. success in cool situations, both on the slopes and in the valleys, but only about 40 per cent. plants survived on bunds; heavy casualties on bunds were due to damage by porcupines.

*Maclura aurantiaca*.—The species has been found easy of handling, and promising for underplanting in *shisham* crops on poor soils in the Multan and Montgomery divisions; in Changa Manga however its growth was reported to have been somewhat retarded by the *shisham* overwood (Tramways).

*Opuntia species*.—*Opuntia ficus-indica* has done very well in Pabhi, and *Opuntia dillenii* and *monacantha* in the erosion demonstration plot at Nurpur.

*Parkinsonia aculeata*.—It is well adapted for sandy soils in the plantations, but in Multan division the plants suffered from frost. Sowings are successful at Nurpur in patches and trenches, but seedlings are damaged by hares (Research).

*Prosopis juliflora*.—Only the Argentine form has proved fully frost hardy. Contrary to expectation plants raised from seed collected from trees of Mexican and arid forms have not proved hardy; frost damage was reported from all the divisions in which trial was made with seeds of these forms. Argentine form is indicated as the best in the plantations and arid form in the Kalachitta hills. Sowings of Australian form have been successful in Depôt West division, and its planting in the Phillaur reserve (Upper Bashahr). Plantings of Mexican and Argentine forms also have given satisfactory results in Sambalpani (Research).

*Rhus lancea*.—Sowings in the open did not prove satisfactory, (Multan), but planting has been successful (Montgomery, Research). Height growth is good, but crown development is not sufficiently vigorous to kill out *dab* (Montgomery, Research).

*Schinus terebinthifolius*.—Plants were established but did not prove frost hardy in the plantations (Montgomery, Multan, Research).

*Thuja plicata*.—Planting has been very successful in all the forests, this is much the most promising among the exotic conifers so far tried.

#### (vii) Nursery Work.

Three main nurseries were maintained at Manali, Chichawatni and Sambalpani for research with exotics and indigenous species

which are likely to be of value for silvicultural, afforestation and counter-erosion purposes in the varying conditions in the high hills, arid low hills and irrigated plantations. The study of fodder species, manurial treatments of beds and methods of improving nursery technique also received attention. A large stock of seedlings was raised for distribution to the divisions and other Government departments. Apart from these research centres nurseries were maintained by territorial divisions. At Khanewal, thinning in nursery beds was found very helpful in stimulating vigorous growth of *Morus alba* and *Melia azedarach* seedlings which were thus made available for handling early in the season. Two thinnings were found necessary, the first when seedlings were 4' 6" high to space them 3"-4" apart, and the second again when they were about 1' high to space them 6"-10" apart. With early handling of plants, the beds could also be emptied in time for the next sowings. Trials were made with 34 species. Two *shisham* nurseries were started to meet local requirements for stumps instead of importing them from the plantations (Depôt West).

#### (viii) Reclamation and Afforestation.

At Nurpur, counter-erosion work was started in 1934 in a plot located on a badly eroded slope. Different kinds of plants tried include species noted for thicket forming (*Agaves*, *Ala vera*, *Opuntia*), quick growth (*Acacia catechu*, *Pithecolobium*, *Leucaena glauca*), browse resistance (*Prosopis juliflora*, *Thevetia nerifolia*, etc.), and mat forming grasses. Planting has been augmented by natural seedlings of woody plants and grasses. The area provides a good demonstration of the effect of plant cover in checking erosion, but owing to concentration of road run-off in the nalas, some simple engineering work has also proved necessary to stop further deepening of nala beds. A detailed study was made of badly affected areas in the Jhelum and Kangra districts, and control measures suggested. A comprehensive erosion survey was completed for the Uhl catchment area where control measures are necessary to prevent further degeneration of soil cover and erosion in order to conserve the winter stream-flow which is so necessary for the Hydro-electric Project. Co-operation of Agricultural and Veterinary officers of the Province and of the new Animal Nutrition Section of the Animal Husbandry Research has been sought in assessing the quantity and quality of cut fodder from our closed areas and in the more general problem of the improvement of fodder production from wild lands as a whole. The great possibilities for increased fodder production as the immediate

result of erosion control projects has been clearly proved by our work in Nurpur Kangra, Kalachitta and the Salt Range (Research).

Discharge observations were recorded for streams from the reclamation area in Pabbi for comparing run-off from afforested and non-afforested areas (Lahore). The results have been correlated with torrent discharge data obtained by the Irrigation Branch for this area. The results have been published in *Current Science* (Research).

#### (ix) *Tending.*

Sets of comparative thinning plots were laid out in young deodar crops to study the relative development of stems under differential thinning treatment, and to demonstrate the value of heavy ordinary, crown and free thinnings in young pole and sapling crops (Research). Comparative thinning plots were also laid out in the dry zone in C. 183 above Purbani, where C and E grade thinnings were carried out (Upper Bashahr). *Phulai* was cut in the olive plantation at Murat to favour olive (Rawalpindi West). Heavier thinnings than those done previously were carried out in the plantation crops (Multan). Cleaning at 3 years and thinnings at 6 years were found beneficial in the riverain *shisham* crops of seed, sucker and coppice origins.

#### (x) *Miscellaneous Experiments.*

*Bhabar grass.*—Increase was recorded in the yield of grass in experimental plots (Simla).

*Resin production.*—The effect of the application of hydrochloric acid on the flow and yield of resin was investigated; contrary to expectation resin yield per 1,000 blazes was reduced from 69.5 maunds to 61 maunds with the use of the acid.

*Firewood dryage.*—Weighments at Topa taken during the last 2 years show that the loss in the weight of firewood due to drying was up to 60 per cent. with a 20 per cent. *plus* or *minus* variation on account of weather conditions. It was difficult to apply the figure strictly owing to variations in the weather and the lack of uniformity of the firewood material itself as regards conditions of dryness (Rawalpindi West). These figures have been correlated with dryage data from other departmental dépôts collected previously by research staff, and a publication has been issued (Punjab Forest Records No. 3) which should be of considerable value in standardising dryage losses on a reasonable and proved basis instead of mere guess work (Research).

## II.—STATISTICAL RESEARCH.

*Bamboo plots.*—In the all-India co-operative experimental plots in Hoshiarpur, fellings were carried out in the sub-plot worked under a 3-year felling cycle, and necessary measurements recorded. Observations show that the size and number of new culms produced is greater in clumps opened under heavy thinnings than in relatively congested clumps (Research).

*Sample plots.*—A replicated set of comparative thinning plots was laid out in Kulu in young deodar crops; individual stems were classified according to Craib's crown classes. The analysis of data showed that growth vigour was correlated with the crown class of trees. The results were presented at the 1937 Punjab Forest Conference (Research).

Sixty-one sample plots were remeasured, 35 in Kulu, 9 in Seraj, 12 in Multan, 3 in Tramways, and 2 in Lahore division. Of these 6 were felled and fully measured, 4 in Multan and 2 in Lahore division (Research).

Maps were prepared showing the position of sample plots distributed throughout the province. History sheets were completed for all the plots, giving crop data for each plot for ready reference (Research).

Appendix I gives the distribution at the close of the year of all the sample plots in the province.

*Single tree data.*—Single tree data collected by territorial divisions was checked and sent to Dehra Dun for computation. Summary results were kept posted to date in Form No. 10.

## III.—MISCELLANEOUS.

*Rainfall data.*—Rainfall statistics collected in the territorial divisions were maintained and a consolidated annual statement prepared (Research).

*Photo collection.*—Indexing and filing of photographs of forest and publicity value was continued. The total collection as it stood at the end of the year was 1163 negatives, 1556 prints and 284 lantern slides.

Lantern slides were arranged in sets to facilitate their issue for publicity work which is being carried out in co-operation with the Rural Reconstruction Department (Research).

*Records.*—12 specific and 2 general files were opened. The total number now stands at 154 specific and 327 general files (Research).

*Library.*—133 new publications were added in addition to serial bulletins and periodic literature on forestry subjects (Research).

*Working Plans.*—The position with regard to new plans is as under:—

*Working plans and schemes completed—*

Arafwala Plantation Working Scheme.

*Working plans and schemes under preparation—*

Working plan for—

Changa Manga.

Daphar.

Simla Municipal Forests.

Throach State.

Working scheme for the belas in the Chenah and Jhelum rivers.

*Erosion and forestry models.*—A set of three models showing the bad effects of forest destruction and subsequent erosion has been prepared and is being duplicated for use in (a) Lahore Museum (b) Commissioner Rural Reconstruction's permanent exhibit at his office (c) demonstrations at farmers' weeks, fairs, melas and other exhibitions (Research).

*Staff.*—Dr. R. M. Gorrie was in charge of Research division throughout the year. Messrs. I. D. Mahendru and R. S. Chopra remained attached, the former worked as general assistant for all divisional work and in charge of the railway planting; the latter in charge of sample plot measurements and research work at Chichawatni and Samhalpani.

Bh. Gurbachan Singh, Forest Ranger, was in charge of works in Kulu, and L. Chaman Lal, Forest Ranger, of works in Nurpur and miscellaneous duties at headquarters including demonstration of models.

## UNITED PROVINCES.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

As sal forests are the most valuable and the most extensive of our commercially exploitable forests the problem of sal regeneration continues to be the most important item of silvicultural research and experiment. The number of sanctioned experiments under the Silviculturist was 56, the same as last year, and 3 new ones were being laid out at the close of the year. A few of the old experiments are being converted into preservation plots. The number of divisional experiments was 52, two old experiments were written up and closed and 22 new ones opened, the majority of which deal with the *de novo* regeneration of sal.

(ii) *Natural Regeneration.*

## (a) From Seed.

2. *Shorea robusta* (sal).—There really is not much to add to what was stated last year concerning the development of whippy and woody plants when given adequate overhead light, protection from browsing, and protection from weed competition. The position up to date is adequately summarised in Mr. Smythies' article in April 1936 *Indian Forester* and Mr. Mobbs' article in August 1936.

Fencing, when sufficiently adequate, seems to be more beneficial to regeneration that is regularly burnt than to regeneration that is regularly shrub cut. In fact deer browsing may in some cases be beneficial in keeping down weeds and shrubs in areas regularly shrub cut. In unfenced areas, however, deer do much more damage in weeded lines than in unweeded areas. Shrub cutting appears to help sal both in height growth and stocking better than burning in practically all conditions and brings in grass quicker. Severe burning seems to cause considerable die back, although this is probably no greater than occurs in areas of heavy undergrowth which cannot be burnt properly and in which the sal is smothered. It does appear, however, that subsequent development is much hindered by excessive canopy and in some divisional experiments steps are being taken to reduce the canopy.

3. The Silviculturist completed a final layout in the series of large scale experiments in the North Kheri *damar* (Champion's type

B. 3). In this the area was fairly adequately stocked with small seedlings which had not yet reached the whippy stage. In the new divisional experiments to attempt the *de novo* regeneration of sal for one reason or another, poor soil, excessive rain, etc., practically all the fresh seedlings obtained died during the first year. The experiments will continue.

Arrangements are being made in all the large fenced experiments for individual seedling study to observe fluctuations caused by die back and to trace the progress from recruitment to the whippy stage.

(b) From Coppice.

4. *Acacia arabica* (*babul*).—A mild year for frost and good rains were beneficial to the *bahul* coppice in Etawah in that the surviving shoots developed well, but mortality from previous frosts has now risen to 64 per cent.

5. *Hill oaks*—*Quercus incana* (*banj*).—Coppice, freed from overhead cover is developing well and shows a height increment from 58" to 66", but after eight years is not yet free from browsing or suppression by undergrowth. *Quercus lanuginosa* (*rianj*) also shows similar development but *Quercus dilatata* (*tilonj*) coppices very poorly only about 9 per cent. of the original coppice still surviving.

(iii) Seed Supply.

6. The Clutterhuckganj seed store continued to collect, distribute and arrange for indents of seed. The largest demands were for Burma teak (56 maunds) and mulberry (21 maunds). Germination tests were made on all seed handled.

7. *Acacia arabica* (*babul*) continued quite viable after seven years of ordinary storage. Seed from 3-year old *Dalbergia sisso* and 4-year old *Albizia lebbek* germinated well. *Pinus caribæa* seed from Florida (*via* the Forest Research Institute) give only 18 per cent. germination in nursery beds.

(iv) Nursery Work.

8. *Pinus caribæa* seedlings, after poor germination, largely damped off in the rains and the few survivors were too weak to last through the hot weather.

(v) Artificial Regeneration.

9. Artificial regeneration on a large scale has now become a routine measure in many divisions both with and without *taungya*.

*Shorea robusta* (sal).—There is nothing special to report. Provided advantage is taken of the accumulated knowledge on the subject and areas suitable for growing sal are chosen, there is no difficulty.

10. *Acacia catechu* (khair).—The few cuttings that survived in the Lalkua experiment have been almost entirely wiped out by browsing and grass competition. It may be taken as definite that the best way to regenerate this species artificially is by sowing.

11. *Pollinidium angustifolium* (baib or sabai).—The Ujhani plantation now six to eight years old gave a yield of about 21 maunds (one day dried) per acre chiefly owing to a favourable monsoon. A considerable quantity of natural regeneration has come in.

The divisional experimental baib plantations in Pilihhit and South Kheri have proved very profitable especially the latter; in the former division considerable damage was done by the excessive rains in 1936. In South Kheri there is a parallel experiment to determine the optimum spacing which at present appears to be 2' x 2'. These experiments will shortly be written up. On suitable areas baib is easily and profitably propagated.

12. *Santalum album* (sandal).—No further sowings were made by the Silviculturist. By regular weeding clumps of healthy sandal have been raised, mostly from the 1933 and 1934 sowings, the best being up to 10' high. In Jbansi recruitment continues but mortality is rather high. This is possibly due to the unsatisfactory condition of the hosts. Sowing and planting is now being tried with suitable hosts.

13. *Tectona grandis* (teak).—The all-India teak seed origin experiments continued satisfactorily. In Gorakhpur the plots were thinned and turned into sample plots. In Haldwani as there was practically no frost better growth was put on, but the general form is very poor.

#### (vi) Reclamation and Afforestation.

14. *Usar*.—Leaflet No. 8 recently published gives an up-to-date account of the Makhdumpur experiment. Owing to favourable rains in 1936 the yield in one plot increased to as much as 20 maunds per acre. In Partahgarh District a small scale experiment to afforest mild *usar* with well tried species with irrigation by percolation was begun.

15. *Bhur*.—Nothing new to report. The good rains of 1936 did much good to most of the experimental plantations on *bhur* areas.

(vii) *Tending.*

16. Nothing new to report.

(viii) *Mixtures.*

17. In the Saharanpur *taungyas* where mixtures of commercial and lopping species are being grown, it seems best to mix species by lines, rather than in the lines.

(ix) *Underplanting.*

18. Nothing new to report.

(x) *Silvicultural Systems.*

19. Nothing new to report.

(xi) *Miscellaneous.*

20. The resin tapping experiment at Garhkheth in Almora continues. Results are not definite but it appears that deep (2") tapping is most productive and that twisted fibre trees give a higher yield than straight fibred trees. A small experiment of treating blazes with a 20 per cent. solution of hydrochloric acid gave at first an increased yield followed by a considerable decrease.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

21. Working plans for the Haldwani, Jhansi and East Almora divisions and for Landour and Lansdowne Cantonment forests were completed during the year. Working plans were in preparation for the Naini Tal, Lansdowne and Saharanpur divisions and for the Muktesar Laboratory forests. Preliminary working plan reports were written for the South Kheri division and the Mussoorie Municipal forests. During the working season preliminary reports were also written for the Garhwal division and the Pauri (Garhwal) Fuel, Charcoal and Timber Supply plan.

(ii) *Yield Tables.*

22. Sixty-three permanent sample plots were remeasured and six new plots in plantations were laid out. Six more linear sample plots, totalling seventeen miles, were laid out in Champion's sal types B3, B4 and A2, the two latter being new types hitherto not taken up. The total number of linear plots is now 36, with a total of over 58 miles in five different types.

(iii) *Bark Measurements, etc.*

23. Nothing to report.

(iv) *Miscellaneous.*

24. The fourth edition of the Forest Pocket Book by Mr. S. H. Howard, I.F.S., was published during the year. Four more leaflets, " Porcupine Proof Fencing ", " An Approximate Volume Table for *haldu* ", " Second Interim Report on the Makhdumpur *Usar* experiment " and " Record of Seeding of the Common Tree Species in the U. P. " were issued during the year.

25. The staff employed on Silvicultural and Statistical research work consisted of the Silviculturist, the Assistant Silviculturist, one forest ranger, two deputy rangers and two foresters.

## CHAPTER III.

## FOREST BOTANY.

## ASSAM.

## I.—OECOLOGY.

The collection of specimens from the sal forests of Goalpara was continued but little progress was made for want of staff and funds. Nowadays owing to the numerous duties which a Divisional Forest Officer and his staff have to carry out, they have little time to devote to the collection of specimens. It is hoped, however, that during the revision of the Goalpara and Kamrup working plans the Officer-in-charge will be able to collect data for this very important work.

Collections of plants have been made in the interesting relict forests of the Shillong plateau in order to determine what is the actual climax forest of the Khasi and Jaintia Hills above 4,000'. These relicts have been preserved from time immemorial because they are places of worship or the abode of evil spirits; no trees are cut, no cattle grazed or any disturbance of the vegetation allowed to take place. The advent of Christianity (as a result of which all interesting beliefs and customs are thrown overboard) threatens the existence of these primeval patches of forest and it may be that the investigation has only just been started in time. A preliminary examination shows that the true climax is not pine forest (Champion, Types of Forest Vegetation in India) but high forest of broad leaved evergreen species in which the families *Lauraceæ*, *Fagaceæ* and *Magnoliaceæ* predominate.

## II.—SYSTEMATIC.

*Herbarium work and other Investigations.*

Plates of several species of *Phæbe* and the three new species *viz.*, *kaula* (Nowgong), *mekahi* (Sadiya) and *Eugenia* (N. C. Hills) have been prepared and sent to the printers who now await the descriptions in order that they may be published in the Assam Forest Records.

Mr. Purkayastha submitted the descriptions of four new species to the *Indian Forester* for publication, *viz.*, *Salacia khasiana*, *Quercus milroyi*, *Ilex khasiana* and *Purkayasthæa micropora*; the

latter being a new genus and species close to *Micropora* (*Lauraceæ*). He has also been investigating a species of *Eugenia*, which may very well turn out to be a new species, and complete material has been sent to Kew for report.

The herbarium has been maintained in good condition. Very great progress has been made up in the mounting of old specimens, some of which were collected over 30 years ago. The collections have been enriched by about 3,500 sheets collected by the writer (Dr. Bor) in the Aka and Naga Hills. These collections have shown that our knowledge of the flora of Assam is very far from complete. In addition to the new species mentioned above there have been many interesting new records, viz., *Petrocosmea parryorum* C. E. C. Fischer (Lushai Hills); *Oxyspora serrata* Diels, *Lasianthus sikkimensis* H.f. (Sikkim); *Aconitum elwesii* Stapf. (this plant is now in cultivation at Kew; found on Chingkhu, Naga Hills); *Pottingeria acuminata* Prain; *Dioscorea kamoonsensis* Kuuth var. *staminea* Prain et Burk; *Gardenia coronaria* (Chittagong); and several others.

The genus *Aconitum* was stated in Volume I, Part I, Flora of Assam, to be absent from the province. There are, however, at least three species, viz., *Aconitum nagarum* Stapf. (Japvo, Naga Hills), *A. elwesii* Stapf. (Chingkhu, Naga Hills) and *A. lycoctonum* Linn. (Aka Hills). As the Daffs are accustomed to tip their arrows with aconite, there must be another species in these hills as the last named plant is non-poisonous.

It is, however, in the family *Gramineæ* that very real progress has been made. The writer spent 6 months in the Kew herbarium in 1936 by the courtesy of Sir A. Hill, the Director, and had the able advice of Mr. C. E. Hubbard, the Agrostologist. All the sheets of *Gramineæ* were identified in the Kew herbarium and intensive collection has proceeded during the past two years. The result of this has been a singularly complete collection of Assam grasses. Several species not collected since C. B. Clarke left the hills over 50 years ago, have been rediscovered and four new species are about to be described.

In connection with grasses, the most noteworthy event of the past few years has been the introduction of fodder grasses into Shillong. Common English species such as *Phalaris arundinacea*, *Anthoxanthum odoratum*, *Lolium perenne*, *Arrhenatherum elatius*, *Holcus lanatus*, etc., have spread all over the station and in one case the first named has been found 16 miles away. The Agricultural Department have introduced *Panicum maximum*, *Pennisetum purpureum* and several others.

Throughout the year the greatest assistance has been rendered by the staff of the Royal Botanic Garden, Kew, that of Sibpur, and the Forest Botanist, Dehra Dun, and they have placed us under a very great obligation.

A large amount of identification work was carried out for Divisional Forest Officers during the year. The work of poisoning the collections was carried out as far as possible.

Duplicate herbarium sheets were distributed as follows;—

Royal Botanic Gardens, Kew . 4 sheets of rare grasses.

Herbarium of the Federated Complete flowering and fruiting  
Malay States. materials of *Shorea assamica*.

The following herbarium materials were lent for study to other persons and institutions:—

Mr. A. Das, Late Botanical Officer.	Sheets of important species of the groups <i>Gamopetalæ</i> and <i>Apetalæ</i> for teaching Botany to the students of the Lady Keane Girls' College, Shillong.
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Seeds of the following species were supplied as follows:—

<i>Coffea khasiana</i>	. . .	To Royal Botanic Garden, Sibpur, for supply to institutions outside India.
<i>Tephrosia candida</i>	. . .	To Plant Pathologist, Bombay Presidency, Poona.

New exchange relations were opened with the following and publications and herbarium materials were received and distributed mutually:—

- (1) Prof. S. P. Agharker, Botany Department, University College of Science, Calcutta.
- (2) Director of Gardens, Straits Settlement, Singapore.
- (3) Forest Botanist, F. R. I., Kepong, Selangor, Federated Malay States.
- (4) Prof. T. Tanaka of the Imperial University, Taihoku, Formosa, Japan.

Various enquiries of scientific and economic importance were dealt with by this herbarium through the Conservator, Divisional Forest Officers and Institutions and other concerns in and outside India.

Dr. E. K. Janaki Ammal, Geneticist, Sugar Cane Station, Coimbatore, paid a short visit to the herbarium during the year.

The herbarium continues to justify its existence and is constantly and increasingly used for reference not only by local officers but also by scientific Institutions in India and in other parts of the world.

### Staff.

The post of the Botanical Officer was held by Mr. C. S. Purkayastha, Deputy Conservator of Forests, till November 1st, 1936, when Dr. N. L. Bor, D.Sc., I.F.S., took over the duties. He held the charge for the remaining period of the year.

The staff carried out the usual routine duties and all collections made during the year were dealt with. Proposal for confirmation of the staff is under the consideration of the Government.

### III.—PATHOLOGY.

A specimen of *Leersia hexandra* Sw. was sent to the Mycological Laboratory, Kew, where it was found that the spikelets were infected with *Testicularia leersiae* Cornu, a fungus hitherto only known from Africa. A species of *Peridermium* was discovered on the needles of *Pinus khasya* hitherto unknown as a host. This fungus is being investigated by Dr. Bagchee, Forest Mycologist.

### IV.—PUBLICATIONS.

Printing of Part II, Volume I, of the "Flora of Assam" was finished during the year.

The report on the known poisonous plants of Assam was submitted during the year, and to make it as useful as possible in its next edition further attempts are now being made to collect complete botanical specimens of the species whose vernacular names could only be mentioned therein at the time.

### BENGAL.

Work on the revision of the Chittagong flora could not be undertaken during the year.

Dehra Dun continues to give valuable assistance in the identification of doubtful and unknown specimens.

No work other than the compilation of a list of some of the known medicinal plants could be undertaken during the year. Owing to lack of staff and proper facilities and equipment this wide field of investigation cannot be tackled.

## BIHAR.

## I.—ECOLOGY.

*Soil Samples.*

## Saitba Sabai Plantation, Kolhan Division.

Four samples of soil were sent to the Agricultural Chemist, Sabour, from Kolhan division, Saitba *Sabai* plantation, for analysis. The results are tabulated below:—

Lab. No.	Description of samples.	Moisture.	Loss on ignition.	Total organic Nl.	Available P <sub>2</sub> O <sub>5</sub> .	Available K <sub>2</sub> O.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
	Soil samples from Kolhan Forest division <i>sabai</i> plantation—					
712	0-3" . . . . .	1.19	7.38	0.32	0.0011	Traces.
713	3"-9" . . . . .	1.11	6.04	0.101	Traces	Do.
714	9"-18" . . . . .	1.46	5.33	0.078	Do.	Do.
715	18"-36" . . . . .	0.94	5.48	0.059	Do.	Do.

The soils contain negligible quantities of available mineral nutrients but are rich in nitrogen and organic matter. From the general appearance and texture of the soil it appears to be *subjected to erosion*.

There is plenty of nitrogen, the essential nutrient for *sabai* plantation and an addition of phosphatic and potassic fertilisers especially phosphate is desirable. An experiment has been laid out on these lines.

## Debour—Rajauli Road East of Singirichi Hill.

Three samples of soil labelled (1) top (no sal), (2) along road side (sal), (3) middle (sal) respectively. The analyst was requested to find out why no sal regeneration was to be found growing in No. 1 soil, and only a small quantity in sample No. 3. The result of analysis is given below and compared with the results of mechanical analysis of sal area in the New Forest and coppice area

of Lachiwala sal forest where very little natural regeneration is reported to take place:—

	Bihar soil No. I top (no sal).	Bihar soil No. II along road side (sal).	Bihar soil No. III middle (sal).	Sal area New Forest, F. R. Insti- tute, Dehra Dun.	Coppice area Lachi- wala, Dehra Dun Divn.
Stones & gravels . . .	nil	nil	..	..	..
<i>Fine earth.</i>					
Coarse sand, per cent . .	14.34	44.12	28.12	27.5	} 7.6
Fine sand, per cent . .	28.29	19.17	28.24	26.0	
Silt, per cent . . .	18.20	14.30	13.75	35.8	72.5
Clay, per cent . . .	32.40	18.40	24.80	9.0	17.7
Moisture, per cent . . .	4.25	2.12	3.33	1.3	1.5
Loss by solution, per cent .	2.49	1.06	1.73	..	..
Difference, per cent . . .	0.03	0.83	0.03	0.4	0.7
	100.00	100.00	100.00	100.00	100.00
Organic matter (loss in ignition)	4.09	2.31	3.48	3.16	8.6
Class of soil . . . .	Light clay.	Sandy clay loam.	Sandy clay.	Loam.	Silty clay loam.

The above analysis shows that soils I and III are rather clayey soils and No. II, although clayey, is of more open texture but none of these bears any comparison with the New Forest soil which is very much open in texture. The Lachiwala soil is inferior in texture to the No. II soil and although less clayey than No. I and No. III soils it may be considered as of inferior texture in so far that it contains very high percentage of silt and very little of sand.

#### *Soil moisture tests.*

Bamiaburu and Sangajata, May 1937.

The differences in soil moisture within and without the irrigated areas are seen from the following moisture tests carried out on samples of soil taken on May 6th, the hottest time of the year. The first sample was taken at Bamiaburu itself just below and to the south-west of the hungalow, not under direct influence of any channel irrigation. The second sample was taken at Sangajata six miles to the south and outside all irrigated influence. Both were taken in road cuttings, three inches below the top surface of the soil and 3" into the bank. The Bamiaburu sample shows 6.10 per

cent. moisture as against 3.23 per cent. at Sangajata. Hole, some years ago in his "Regeneration of Sal experiments" said that there should be 5 per cent. moisture in the soil for sal growth to take place. The Bamiaburu sample fulfils that condition. This may explain why sal seedlings are coming in so profusely and not dying back the following year.

## II.—SYSTEMATIC.

*Nil.*

## III.—PATHOLOGY.

Insect attacked plants of *Aleurites fordii* and shoots of *Cedrela toona* were sent to the Forest Research Institute for identification.

For the former the Forest Botanist remarked that the plants show pink to black coloured rots in their collar region, the tissues of the collar portion being heavily infested with hyaline to dark coloured hyphæ. As no fruit bodies of fungi were found with the rot, identification of the fungus was not possible. Instructions have been given to the Forest Ranger in charge of the Hino Experimental Garden to find out plants in a dying condition, complete if possible above and below ground, with fructification, for identification purposes.

As regards *Cedrela toona*, the Entomologist identified the insect to be *Hypsipyla robusta*, Moore (*Pyrilidae*). For the life-history see Indian Forest Record, Volume VII, Part VII of 1919.

## BURMA.

The post of Forest Botanist remained unfilled. The Silviculturist (Mr. C. W. D. Kermode) held charge of it in addition to his own duties.

Maung Kan, Curator, was in charge of the herbarium throughout the year. He was assisted in his work during the rains by Foresters of the Silviculturist's staff. Mr. Kermode reports as follows:—

Three hundred and one botanical specimens were mounted during the year bringing the total to 39,399 sheets in the herbarium at the close of the year. Cleaning and poisoning of specimens was done by the Silviculturist's staff during the rains. There is a good deal of damage which was mainly done by insects when the herbarium was in Rangoon. There are few signs of fresh damage. A considerable number of partially named specimens was sent to Calcutta and Dehra Dun for naming by these institutions.

and those for which identifications have been received have been added to the herbarium. One hundred and twenty-nine specimens of ferns were sent on loan to the Curator, Royal Botanic Garden, Calcutta, for examination. These have been examined by him at Kew and have been returned named or confirmed. A further recent collection of ferns together with a number of old herbarium sheets of fern allies have recently been sent for examination.

Specimens were distributed to the following :—

- (1) Forest Botanist, Forest Research Institute, Dehra Dun. Three sheets of *Quercus* spp.
- (2) Curator, Philippine National Herbarium, Bureau of Science, Manila. 52.
- (3) Curator, Royal Botanic Garden, Sibpur. 30.
- (4) W. W. Howard & Co., London. Two sheets of Burma *padauk* (*Pterocarpus macrocarpus*).
- (5) Botanical Museum of Harvard University. Two sheets of *thisi* (*Melanorrhæa usitata*).

70 lbs. of acorns of *Quercus serrata* (*nyan*) were supplied to the Chief, Division of Management, Pretoria, South Africa.

We are especially indebted to Mr. C. E. Parkinson, Forest Botanist, Forest Research Institute, Dehra Dun, for a collection of 186 botanical specimens for our herbarium.

Contributions were also received from :—

- (1) Mr. H. C. Smith, Conservator of Forests, Chindwin Circle, Maymyo. A collection of specimens made on Mt. Popa in October 1936. These have not yet been named. A collection of specimens made by Mr. Smith in Padaung Reserve, Myitkyina, in March 1936 has been named partly here and partly at Calcutta.
- (2) Mr. G. S. Shirley, Conservator of Forests, Northern Circle, Maymyo.
- (3) Mr. D. J. Atkinson, Conservator of Forests, Utilization Circle, Rangoon.
- (4) Mr. C. W. D. Kermode, Silviculturist, Maymyo.
- (5) Mr. W. C. F. Carroll, Divisional Forest Officer, Southern Shan States.

A good deal of the Curator's time was occupied in mounting, writing up labels, disinfecting specimens and in despatch of specimens to other herbaria for comparison and naming. He has now started on a classification of the herbarium with the object of, as

far as possible determining the distribution of the species collected. When this has been completed it is hoped that it will serve as a basis for a revised edition of Lace's "List of Trees, shrubs, etc., in Burma" which is now out of date. Identification of a number of specimens sent by local officers has been done by the Silviculturist, Maymyo.

A collector, Maung Po Khant, formerly a forester on the staff of the Forest Botanist, was sent out to the Wa States with the Sino-Burma Boundary Commission. He returned after the close of the year with a collection of 140 botanical specimens as well as a number of orchids. The thanks of the Department are due to the Officer in charge for permitting the collector to accompany the expedition and for arranging for his transport. The collection should be of interest, as it is believed that this region has not been botanically explored.

*32. Botanical Gardens—Charge.*—Mr. C. T. Bogg, Superintendent, was in charge throughout the year. He also held additional charge of the Government House Gardens, Maymyo.

*Municipal Contribution.*—The Maymyo Municipality again contributed Rs. 1,200 towards the maintenance of the garden, which sum was included in the total grant for upkeep.

*Visitors.*—His Excellency the Viceroy of India honoured the garden with a visit during his last official visit to Burma. His Excellency expressed himself as being pleased with the lay out and showed interest in the orchid collection and fruit producing plants. His Excellency the Governor and Lady Cochrane were also frequent visitors.

That the garden is appreciated, there can be no doubt, judging by the number of visitors, especially those from the mofussil.

*Progress.*—Much useful work was accomplished during the year.

A new "Sulky" mower was purchased at a cost of Rs. 800 which made it possible to maintain the entire lawn area of the garden in a satisfactory manner. The new machine is extremely light and easily worked, with little or no strain on the hullocks, with the result, that what used to take a month to cut with the old type of mower, can now be cut in 10 days.

*Roses.*—The rose garden, which has proved a decided attraction, was re-arranged and several new varieties of roses imported from England were added to it.

*Shrubberies.*—250 shrubs were planted to fill up vacancies of the past five or six years.

*Buildings.*—The mower godown was rebuilt at a cost of Rs. 257. The remaining buildings were earthoiled and maintained as usual.

*Roads and Paths.*—In the *Rosaceæ* area, 693 feet of paths were treated with Colas. The remaining paths and roads were weeded more frequently, though at a greater cost. This is an item of expenditure which will tend to decrease with the gradual tarring of all roads and paths.

*Water Supply.*—The water supply plant was worked for 253 hours at a cost of Rs. 670-4. Of this sum, Rs. 480 was for driver's wages; Rs. 149-15 for fuel and lubricating oil and Rs. 40-5 for other running charges.

*Systematic Work.*—Advantage was taken of favourable conditions to plant out several representative species in their respective family plots. 118 plants were put out.

The number of plants now in their correct family plots to the end of March 1937 is 1,487, representing 56 families, 256 genera and 513 species.

*Orchids.*—Visitors continue to show considerable interest in the orchid house in which there are now 166 named species.

*Acclimatization—Plants.*—There has been an appreciable demand for flowering trees and shrubs and consequently, a new plant catalogue, with additional sections for fruit trees and orchids, has been printed and distributed.

*Season.*—The season was not as favourable as last year, though the rainfall, 56.14" was up to average. The early cessation of the rains in October resulted in plants not being able to stand up to the heavy and persistent frosts of January and a number of plants were badly damaged, particularly, *Jacaranda*, *Cannas*, *Erythrinas* and *Millettias*. The lake also suffered and started to decrease earlier than usual.

*Flower Show.*—On the recommendation of the Garden Advisory Committee and under the Chairmanship of Mr. T. H. G. Bostock, the Maymyo Flower Show was held at the end of March 1937 after being in abeyance for six years.

*Finance.*—The revenue realised was Rs. 1,477-13, which is a record for the garden. The expenditure was Rs. 18,055-6 against an allotment of Rs. 18,173. Establishment accounted for Rs. 9,359-5 and maintenance Rs. 8,696-1. Under establishment, Rs. 1,200 was leave-salary of the late garden Overseer. Actually,

the nett cost to Government for the Botanical Gardens during the past year has been the lowest on record, after taking revenue into consideration.

## CENTRAL PROVINCES.

### I.—OECOLOGY.

57. *Preservation plots*.—According to the list published in the triennial programme for 1936-39, there were 9 plots in the province at the beginning of the year. Judged from the standard now required for such plots, however, at least 5 of these will have to be abandoned, and the records of the remainder entirely rewritten.

The aim is to eventually lay out a few plots in each of the important forest types of the province and Mr. Champion's "Preliminary survey of forest types of India" is taken as the basis of classification. Certain modifications are, however, necessary in the terminology to suit local conditions. The most important of these is the omission of the sub-division of a group into Northern and Southern counterparts. As the Central Provinces lie in the transition zone this differentiation is nowhere noticeable and is in fact very confusing. As against this we have three well defined sub-groups, *viz.*, mixed forest without teak or sal which is the basic type, and its several phases with preponderance of teak in the northern, western and the central part of the province and the preponderance of sal in the eastern part. A note setting forth the proposed modifications is under preparation. In the meanwhile selection of suitable areas for laying out the plots has already been taken in hand.

58. *Karka bamboos*.—The dense and switchy growth of *Dendrocalamus strictus* bamboo near Muki in Balaghat which has hitherto been considered a dwarf variety of the species, is now observed to be gradually forming into clumps and growing like the ordinary bamboo, showing clearly that the thicket like growth for a somewhat longer period than usual was probably due to a very prolific seeding and to the exceptionally favourable conditions for its regeneration under a light cover of sal.

### II.—SYSTEMATIC.

59. *Crinum latifolium* was found growing fairly extensively in the Banjar reserve of Mandla. This species had been located previously at Burghat in the Melghat and at Ladi in Betul.

*Careya herbacea* a very common plant in sal *maidans* is also found to occur at Mowar in Betul. In the latter place it was

noticed to flower in May and not in June-July as mentioned in Mr. Writts Flora.

60. Seeds of *Cassia fistula* collected in Balaghat and Chhindwara were found to be noticeably different in size as well as shape. The former are big and tapering while the latter are small and oval. Plants are being raised from the two varieties separately to see if there is any difference in them.

### III.—PLANT PATHOLOGY.

61. *Fomes pappianus* is very prevalent in the older *Babul* *bans* of Amraoti. This is chiefly attributed to early congestion in the crop which weakened the plants. Subsequent unfavourable soil-moisture conditions have helped the spread of the fungus. The best preventive measure is to sow lightly and then to start thinning from the second year onwards.

## CHAPTER IV.

## FOREST ENTOMOLOGY.

## BENGAL.

Intensive spraying with a mixture of tobacco, soap and water was carried out to control the pest *Urostylis punctigera* for the 2nd year in succession in *champ* plantations without any effect. It is hoped that investigations on the biological control of this pest will be taken up in future by the Forest Entomologist, Dehra Dun.

## BOMBAY.

A species of *Amsacta* caused heavy defoliation of teak in the first week of July 1936 between Birchi and Dandeli in Kanara N.-D. The insects, however, disappeared suddenly with the advent of heavy rain and as no chrysalises could be collected the identification of the moth was not possible. This species has not previously been recorded to feed on teak and was observed for the first time during the last 8 years.

The larvæ of *Zeuzera coffeæ* were observed on a few sandalwood plants in Siddapur coupe in the Sambrani range. The insect did not spread and no particular damage was noticed. This borer has been recorded as attacking sandal but not to any great extent.

## BURMA.

## A.—PESTS OF TEAK.

I.—*Xyleutes ceramica* Wlk., the Beehole Borer.

## (a) Life History.

*Life History Observation Plot at Thogale, Pyuchaung Reserve, South Toungoo division—*

*1935 generation.*—It was found that only 9 larvæ or 9.2 per cent. of the original attack had survived to pass into their second year, and these had all failed by January 1937. The original attack, i.e., number of new beeholes recorded in June and July 1935, was 98. Subsequently 61 additional beeholes were recorded, but these must be put down as transfers, as it would not be possible for a larva to go undetected in the plot until September. 9 moths (8 males and 1 female) or 9.2 per cent. of the original larval population emerged in March 1936; no second year moths emerged in 1937.

*1936 generation.*—In June 28 beeholes of the new generation were recorded. When the plot was next visited, in August, 6 of these had failed, but 62 new larvæ were found, bringing the total original attack to 90. By September 35 more had failed; but 20 beeholes, hitherto unrecorded, were found, which must have been transfers from holes recorded as failed. The larval population of this generation, which started with 28 larvæ in June, rose to 84 in August, subsequently falling away to 69 in November, 58 in January 1937, 37 in March 1937, and between 10 and 15 are expected to survive into their second year.

Three moths, 2 males and 1 female, emerged in March after one year.

*Data from Observation Plot Records—*

(i) *Annual incidence.*—The total number of beeholes of the 1936 generation (original attack *plus* transfers) was 129 and is compared with the attack in previous years in the following table:—

Year. (1)	1930. (2)	1931. (3)	1932. (4)	1933. (5)	1934. (6)	1935. (7)	1936. (8)	Period 1930 to 1935. (9)
Total beeholes recorded.	1,102	409	545	701	78	159	129	2,994
No. of trees in plot	247	246	246	245	243	243	241	245
Average beeholes per tree.	4.46	1.66	2.21	2.86	0.82	0.65	0.53	2.04

(ii) *Correlation of annual incidence with moth emergence inside the plot.*—The following table shows the record of moths emerging from trees in the plot from 1932 onwards:—

Year.	MOTHS.			Total.
	Male.	Female.	Sex not known.	
1932 . . . . .	8	3	2	11
1933 . . . . .	8	4	..	12
1934 . . . . .	6	1	1	8
1935 . . . . .	5	1	..	6
1936 . . . . .	8	1	1	10
1937 . . . . .	2	1	..	3
TOTAL .	35	11	4	50

These figures represent an average moth emergence of 4.7 per cent. of the original attack in each generation. Comparing this with the table in paragraph (i) above, it will be seen that

there is a correlation between female moth emergence in the plot and larval population in the same year. Studies of the habits of the female moth itself will have to be made before it can be known how much ground one female covers during oviposition; attack in 1934, 1935 and 1936, when only one female per annum is known to have emerged, was widespread over the 245 trees in the acre plot. Such oviposition habits as have been studied suggest that the female, having found a place to her liking, remains there and only moves on when that particular crevice is full of eggs, i.e., up to about 1,000 eggs are laid in the same place. The record of attacked trees in the plot, however, does not show that those trees near which the female has emerged are attacked to a greater extent than ones further away. Observations still remain to be made on oviposition habits of the females in natural conditions.

(iii) *Proportion of sexes*.—Reference to the above table will show that to date, out of 46 moths, 35 or 76 per cent. have been males and 11 or 24 per cent. females. This is about the normal proportion of sexes recorded from random counts of pupal skins found in this locality.

(iv) *Life cycle*.—Of the 50 moths recorded, 35 or 70 per cent. have emerged after only one year as larvæ, the remaining 15 or 30 per cent. having had a 2-year life cycle. This proportion is not surprising when the low number (about 8-9 per cent. of original attack) of larvæ which survive into their second year is taken into consideration. It is not known whether this proportion holds good in other localities.

(v) *Transfers*.—The original attack, as stated in a previous paragraph, is taken to be the number of new larvæ recorded in the first two visits to the plot in June and July. Fresh holes recorded in September and later visits are assumed to be transfers from other holes recorded as failed.

The following table shows the number of transfers in each year's attack since 1933:—

Year.	Original attack.	Transfers.	Total attack.	Percentage transfers.
				Per cent.
1933 . . . . .	551	115	666	17
1934 . . . . .	58	20	78	25
1935 . . . . .	98	61	159	38
1936 . . . . .	90	39	129	30

It is thought that the number of transfers is somewhat greater than this, as a proportion of the new beeholes recorded at the second visit to the plot in July or August are probably transfers from holes recorded as failed. The greatest number of transfers are recorded in September and November of the first year. In January and March the number of new beeholes is very small and no transfers of second year larvæ have been recorded.

Experiments were carried out to observe the habits of larvæ when removed from the gallery and placed in the open at different periods of the year. It was found that larvæ put on the ground near teak trees did not show any positive tropism towards teak; some larvæ moved past the tree, but the majority, if they were not taken by ants, buried themselves in the ground, where they succumbed. Up to November, larvæ placed on trees rapidly found suitable places, such as old partly occluded holes and deep crevices, and covered themselves with a web within two hours, later forming a gallery in the wood. Older larvæ, similarly experimented with in January, March and during their second larval year, were very sluggish and slow and were all pulled down by ants before they could cover themselves with a web. Further research will be done during the current year.

65 per cent. of the moths which have emerged from 1934 to 1937 have been from transfers.

(vi) *Total larval population in plot.*—From the plot records the total larval population, *i.e.*, the survivors of the previous generation *plus* the current generation larvæ, was worked out for each visit paid to the plot from 1933 onwards. The highest population was found to be present in July—August each year. The highest percentage of failures from natural causes occurs between September and November and in March and April in each generation. Control measures should, therefore, be taken before September when the natural factors are not effective.

(vii) *Survival of larvæ into 2nd year.*—Available statistics from the plot records show that an average of 8.6 per cent. of the originally recorded larval population survives to pass into the second year, and from these, an average of 13.3 per cent. emerge as moths at the end of the year.

(viii) *Effect of aspect on beehole incidence.*—The average number of beeholes per tree, was, as last year, slightly greater on the southern than on the northern aspect.

(ix) *Variation of beehole incidence with size of trees.*—As in previous years, the larger girth classes were attacked to a greater

extent than the smaller ones; the following table shows the distribution of attack, and percentage of trees in each class which were attacked:—

Girth Class.	1' 1"— 1' 6".	1' 7"— 2' 0".	2' 1"— 2' 6".	2' 7"— 3' 0".	3' 1"— 3' 6".
(1)	(2)	(3)	(4)	(5)	(6)
No. of trees . . . .	28	82	56	36	5
Percentage of trees attacked	18%	25%	64%	52%	60%
Incidence per tree . .	0.25	0.41	0.62	0.62	1.0

In the whole plot 94 trees out of 241 or 39 per cent. were attacked.

(x) *Effect of undergrowth on beehole incidence.*—The experimental treatment mentioned in last year's annual report was carried on during the year, but it is too early yet to analyse results.

A thinning will be carried out in the plot during the coming year; trees will be felled at various times to see if living larvæ in the thinned stems vacate these for nearby standing trees and to see if moths emerge from trees felled before the normal feeding period is over.

As Dr. Beeson points out, from the evidence available it is likely that a universal factor such as weather or a local factor such as female moth emergence, has a greater effect on annual incidence than locality factors such as girth of trees, aspect, undergrowth, etc.

#### Cages—

(i) *Thogale*.—A large number of larvæ were introduced into the Thogale cage at each visit to the plot, but nearly all were destroyed by ants and termites. Efforts are being made this year to keep these out, as, apart from showing that they can be capable controlling agents, they prevent life history experiments being carried out in the controlled conditions which the caged trees are meant to supply.

(ii) *Zibingyi*.—126 larvæ were introduced into the Zibingyi caged trees in August. No moths emerged, and only 15 survive to date to pass into their second year. A new cage was built at Zibingyi around three teak trees, at the end of the year.

(iii) *Maymyo*.—All the teak trees in the Maymyo cage, being by now riddled with beeholes, were removed, and new stumps were planted in April 1937.

*Moth emergence, 1937—*

(i) *Thogale*.—The Field and Insectary Assistant, Forest Ranger Saw Hla Ogh, was at Thogale, South Toungoo division, throughout the moth emergence period in March 1937. The first record of emergence was on 9th March, and the last 31st March; the assistant left on 2nd April, there still being 17 holes from which emergence was expected. These were inspected daily by a local subordinate and no further emergence was reported.

Twelve female moths and seventeen males were taken, and in addition 2 female and 10 male pupal skins were found making a total of 41 moths known to have emerged, 34 per cent. being females. The area of plantations worked over was 200 acres, and it is probable that the actual moth emergence was considerably larger than this; moths emerging high up in the trees cannot be detected from the ground.

The captured female moths were put into the cage, and, after mating, eggs were collected in tubes for experiments in Rangoon. One thousand tubes, each containing 20-50 eggs were collected, and sent, the morning after laying, to Rangoon.

The egg period at Thogale was again tested and found to be 14-16 days.

Meteorological readings were again taken in the plantations, the highest recorded temperature being 98° F. on the 20th, 23rd-25th March, and the lowest being 57° F. on 9th March. The average maximum shade temperature was 95° F. and the minimum 63° F.

(ii) *Zibingyi*.—At Zibingyi, 1,800 feet above sea level, 22 miles from Maymyo, there is abundant teak of poor quality growing in the unclassified forests. In February it was evident from the emergence holes found, that there was going to be a considerable moth emergence, and this proved to be so. The following table shows the emergence record in detail:—

FEMALES.			MALES.				Total emergence.
Moths collected.	Pupal skins found.	Total.	Moths collected.	Pupal skins found.	Moths taken at night.	Total.	
41	18	59	30	16	120	166	225

Of this total 26 per cent. were females. It is probable that a number of emergences were missed, especially those up in the crowns of the trees.

The locality from which this very large moth emergence took place was an area of about 1 square mile containing scattered groups of natural teak 40-100 years old mostly on old cultivation and inside the village itself. From one small group of trees in the village 12 moths emerged, no fewer than 5 coming from the same tree.

The emergence period lasted three weeks; the first moth emerged on 24th March, the peak of emergence was from 30th March to 9th April, when an average of 3 female moths were taken per day. The greatest number of females to emerge in a single day was 5 on April 7th. The emergence period virtually ended on April 14th, though a single male emerged on April 20th.

Holes from which emergence was foreseen were covered with wicker baskets, and these were inspected daily. Females which emerged were put into a small wire-mesh cage in the bungalow. Males were usually attracted the same night and mating was achieved. The number of males attracted was in proportion to the number of unmated females in the cage; on April 3rd when there were 6 unmated females in the cage, 34 wild males were attracted between 8 P.M. and 3 A.M. Males usually came between 11 P.M. and 1 A.M., and normally three or four arrived together. They were captured and put into the cage containing the females, and if put directly below the female mating was achieved without difficulty. If merely introduced into the cage and allowed to fly about on their own, they were very apt to batter themselves to pieces without finding the female, the location of which appeared to necessitate the flying of males in narrowing circles, which they were unable to do in the cage. The same habits were observed in the large outdoor cages.

The following night fertilised females were transferred to cylindrical wire-mesh cages about 1 foot high by six inches diameter, and laid eggs readily, thrusting the ovipositor through the mesh into tubes filled with crumpled paper held in readiness. 1,800 tubes of eggs were collected, of which half were sent to Rangoon for laboratory experiments and half were used for local experiments; a summary of these is given in a later paragraph.

The egg period at Zibingyi was 12-14 days, compared with 14-16 days at Thogale, 11 days in Rangoon and 20-22 days in Maymyo.

Meteorological records were kept; a maximum and minimum thermometer was hung on a tree and shaded from the direct sunlight. The highest temperature recorded was 107° F. on April

5th and the lowest 61° F. on 13th and 17th April. The average maximum temperature between 30th March and 30th April was 97·7° F. and the average minimum between the same dates was 66·8° F.

No explanation can be found for the unprecedented moth emergence at Zibingyi this year and the extremely local nature of its incidence. Though hundreds of trees were searched, less than 10 moths were found to have emerged outside the groups of trees in the village and its immediate surroundings, which yielded all the moths recorded in the table. Analysis which it is hoped to carry out in the coming year may give a clue to the reasons for this.

*Experiments with eggs and larvæ in Rangoon and in Zibingyi.*—With the permission of the authorities of Rangoon University, Dr. F. J. Meggitt, of the Department of Biology, again undertook to carry out experiments with the eggs and early larval stages of *ceramica*, testing lethal condition. In the course of them he dealt with nearly 3,000 tubes of eggs collected in the field, and our thanks are due to him and to the Biology Department for this work, which entails constant supervision, and the results of which are complex.

Both Dr. F. J. Meggitt, in Rangoon, and the writer (Mr. P. F. Garthwaite) in Zibingyi, carried out experiments with the early stages, exposing eggs and young larvæ in conditions as nearly natural as possible, for varying lengths of time, in various situations, direct sunlight, shade, compass points on trees, etc. The permutations and combinations of such experiments are manifold. The experiments were carried out after the close of the year and will be dealt with in a subsequent report; valuable information was obtained, which gave pointers to the direction of further research in this field which it is proposed to carry out during the 1938 moth emergence period.

*Alternative hosts of Xyleutes ceramica.*—Of great interest is the following report from the Divisional Forest Officer, Insein (Mr. D. J. Atkinson):—

“ I mentioned that years ago I had once taken what I thought, but was then unable to prove, was a beehole larva in *yemane* (*Gmelina arborea*) at Namtu. By a most curious coincidence I yesterday confirmed this doubtful record, by taking 4 pupal skins, a specimen of removal by woodpecker, and a living pupa, all ex-10 years old *yemane* (*Gmelina arborea*) in a 1927 plantation at Myeungtaga, South Hlaing

Yoma reserve. I, send you the wood specimen, a good museum piece, and the 4 pupal skins herewith—the living pupa I have *in situ*, and hope the moth will emerge in a day or so.

Note the early emergence—a day or so before 22nd February—you will see in Beeson's Records a note of mine recording pupæ in Insein in February, but not moths."

The fact that *ceramica* is able to complete its life history in *Gmelina arborea* and also the early emergence period in Insein are important observations. There is now evidence that the emergence period varies with latitude—it is later in the north than the south, though there is annual variation in each locality. It may be that the growing season ends earlier in the south and hence pupation is earlier, but it is probably due to a variety of ecological factors, such as temperature, leaf-fall, cessation of flow of sap, etc.

Day old *ceramica* larvæ were introduced into *Gmelina arborea* in Maymyo and to date (June 1937) are flourishing in this host.

#### (b) Analysis of Past Attacks.

No analysis was done during the year. Data from previous analysis were re-examined with reference to special points, such as the effect of thinning history on annual incidence, correlation between the number of beeholes showing on the surface of a log and the total number in the log, correlation between annual incidence and moth emergence, and the comparison of the relationship between failed beeholes and moths for light and heavily beeholed localities to estimate the period when natural checks fail in the latter.

It is proposed to carry out beehole analysis by hand in a number of localities in the coming year with a view to settling certain definite problems which were brought out by earlier analysis.

#### (c) Natural Enemies.

The *Ichneumonid* parasite of *Xyleutes ceramics* has now been described and named *Nemeritis tectonæ* J. F. Perk. Two living cocoons were found in beeholes at Thogale, South Toungoo division, on 28th June, and were brought back to Maymyo where a female emerged on 17th July. This specimen lived for 38 days in the insectary but no male was obtained for it. Another living

cocoon was found at Thogale on 12th August, but no emergence took place.

It was mentioned in a previous paragraph that natural control is not effective to reduce the numbers in each generation before September. *Nemeritis* parasitises *ceramica* in June and July, just at a time when additional checks are wanted. The introduction and, if possible, colonisation of this parasite in large numbers would be of great benefit, and preliminary research into the insectary breeding of the parasite is to be undertaken during the coming year. The difficult problem is to obtain living parasites with which to start the first generation.

That ants can be efficient controlling agents of the egg and larval stages of *ceramica* was observed on many occasions. Of 20 larvæ freed on trees for studying transfer habits, 14 were pulled down and killed by ants before they had entered the tree. In the Zibingyi cage, a mass of about 1,000 eggs laid rather openly on the bark of one of the trees were all removed by ants within four days; the work of the ants being observed.

Termites too, in plantations, play their part as controlling agents; this year, particularly, in the Thogale cage, although 250 larvæ were introduced into the trees, only 5 survived at the close of the year, due partly to ants and partly to termites, whose earth walls covered the trees and blocked up the beeholes, killing the inmates. In the observation plot it has been noted that trees which have been covered with termites' walling in the previous rains, rarely get attacked by *ceramica* the following year, the smooth bark surface left after the earth has fallen away being unfavourable both for oviposition and for the young larvæ.

A survey of the species of ants and termites important in this respect will be made during the coming year.

## II.—Defoliators.

No field work was done on the defoliators during most of the year, which was taken up by getting all the parasites bred out from *Hapalia machæralis* and *Hyblæa puera* during the last five years expertly identified, and the results of the five years research written up. Most of the parasites were identified at Dehra Dun, and a comparison of the lists of species bred out of Burma and Madras material showed that an interchange of living parasites between the two countries, with a view to establishing introduced species, would be likely to prove beneficial.

Mr. M. H. Desai, Insectary Assistant, with a staff of two setters, was, therefore, transferred to Insein in March 1937 and a parasite breeding insectary was set up there, housed, through the kind offices of the Veterinary Department, in a large laboratory room in the Veterinary Research Institute, to export Burma parasites to a similar Insectary run by the Forest Research Institute at Nilambur, Madras, and to carry out mass breeding and liberation of parasites sent from there. A stock of *Cedria paradoxa*, a Braconid parasite of *Hapalia macharalis* which does not occur in Burma was safely received from Nilambur, having been sent by ship in cold storage in the adult stage, and at the time of writing breeding is going on successfully and several colonies have been liberated.

The work will continue throughout the year.

### III.—Other Pests of Teak.

*Phassus* sp. (*Lepidoptera*, *Hepialidae*).—Billets of *yemane* (*Gmelina arborea*) containing mature larvæ were collected in the Nanhlaing Reserve, Shwebo, at the beginning of September, and 11 male and 17 female moths emerged between the 24th September and the 19th October. In every case the trees attacked were associated with the creeper *Buettneria pilosa* from which attack had evidently originated.

No mating of the moths bred out was achieved. The adults are very delicate, and in captivity they died within two days, usually in a battered condition; some infertile eggs were laid.

The study of this insect will be continued in the coming year.

### B.—PESTS OF OTHER SPECIES OF ECONOMIC IMPORTANCE.

*Pyinkado* (*Xylia dolabriiformis*) borers.—As indicated in last year's report a preliminary survey of the distribution of the longicorn borers of *pyinkado* was carried out, and specimens were collected from Ataran, Insein, Zigon, Thaton, Pyinmana, Tharrawaddy and Myitkyina divisions.

Ataran division was visited in May and trees were cut up and analysed to trace current and former attacks in the Miok and Dawebank Reserves and in the unclassified forests in these localities. In the Miok Reserve two trees of over 3 feet girth were analysed, and in each tree three galleries of a large Cerambycid, afterwards identified from bred specimens as *Pachydissus* sp. were found. In the Dawebank unclassified forests three trees were analysed, and found to contain 5, 4 and 8 galleries

of *Pachydissus*, eleven of these being of the current year. Many large trees in the Reserve were carefully examined, but no signs of current attack were seen. This corroborates the evidence of the Moulmein mills, which were also visited, that timber from unclassified forests is attacked to a greater extent than that from reserves in this Division. *Pachydissus* attacks the large living tree over 2 feet 6 inches in girth and no galleries were found above 40 feet from the ground. The mature gallery is a large one, running radially for three or four inches and then axially for five or six inches, and galleries up to two inches in diameter were found.

Billets containing living larvæ were caged in Maymyo and so far three adults have emerged at the end of April 1937 implying a life cycle of two years, as the larvæ were well grown when the specimens were collected in May 1936.

Plantation trees in Ataran and Thaton were found to be attacked by the lamiid *Aristobia approximator* Th., which, however, confines its attacks to trees under 10 years old, and which therefore only damages the heart of the tree.

Many specimens of *Dialeges undulatus* Gahan, *Ceresium leucosticticum* White and *Noserius tibialis* Pasc. were bred out of billets from Ataran and Myitkyina. These are normally borers of felled or moribund trees, and the large number of emergences were probably due to hreeding inside the cages.

*Pachydissus* is capable of the greatest amount of damage, and it was presumably the galleries of this species which caused the rejection of sleepers referred to in last year's report; but the preliminary survey in forests reputed to show greatest attack does not lead to the conclusion that damage is severe, nor did inspection of the mills reveal any serious loss in conversion due to insect attack. If millers realise that "wormy" railway sleepers will not be passed, it should be possible for them to eliminate attacked portions during conversion without any great loss.

*Calopepla lecyana* Latr.—The *Gmelina arborea* plantations at Nanttu, Northern Shan States, have now been abandoned, and no further work was done by this branch on the insect. The Divisional Forest Officer reports a moderate attack in a year characterised by heavy rainfall.

*Lyctus* and allied beetles.—The survey of the distribution, biology and importance in Burma of the bostrychid beetles was continued and is not yet complete. *Minthea rugicollis* Walk is the commonest species bred out of material so far collected.

*Ochrophara montana* (Pentatomidæ).—The flowering of *kyathaung* bamboo (*Bambusa polymorpha*) gregariously over large tracts of forest in the Pegu Yomas, led to an enormous population of this bug, which feeds on the seeds of the bamboo. It was so numerous, in some localities, particularly in Yamethin division, that the forest floor and lower undergrowth was covered with a mass of these insects over whole acres at a stretch. Most numerous in June they appeared to have died out by the end of the rains.

*Xyleutes persona* Leg.—A number of ornamental *Cassia fistula* and *Cassia renigera* trees in Maymyo and Rangoon were found to be attacked by this insect and records were kept. From one *Cassia renigera* tree in Rangoon 106 pupal cases were taken in March, implying a considerable recent moth emergence; but fresh pupal skins have been found during most months of the year. This is consistent with the variable length of larval life (18 months to  $2\frac{1}{2}$  years) recorded for specimens in caged trees and with the fact of finding larvæ of several distinctly different sizes at the same time in the same tree.

*Tung* (*Aleurites fordii* and *Aleurites montana*) seedlings in nurseries in the Shan States were reported to suffer to a certain extent from attack by crickets (*Brachytrypes* sp.) and by the weevil *Astychus lateralis* F. Poison baits were recommended for dealing with the former.

*Cedrela toona* in the Southern Shan States was reported to be so severely attacked by the toon shoot borer (*Hypsipyla robusta*) that 126 acres of plantations had to be written off.

### C.—GENERAL INSECTARY WORK.

179 cages were in use at the close of the year, mainly for the breeding of wood boring insects. 2,133 insects emerged and 1,495 were set.

Great progress was made by Mr. L. J. Vernall, during the writer's absence on leave, in writing up breeding cage records and in sending insects to experts for identification. Most of the insects were sent to Dehra Dun where they were dealt with by the Systematic Entomologist and by the Forest Entomologist to whom our thanks are due for the work done in this connection.

The main groups dealt with were the parasites of the teak defoliators and the *Cerambycidæ* and *Bostrychidæ*.

## D.—PROGRAMME.

Dr. C. F. C. Beeson, Forest Entomologist, Dehra Dun, paid a visit, unfortunately curtailed, to Burma in February 1937, and outlined a programme of research, which was accepted at a conference presided over by the Chief Conservator of Forests, in Rangoon, before he left.

## CENTRAL PROVINCES.

## I.—ENTOMOLOGY.

In Supkbar, Balghat, a sal defoliator *Pactes (Ingura) subapicalis* Wlk. was noticed in epidemic form and specimens are to be sent to Dehra Dun for studying the life cycle of the pest.

Samples of match boxes damaged by a powder-pest beetle were sent by the Laxmi Match Factory to the Divisional Forest Officer, Bilaspur, who forwarded them to the Forest Research Institute, Dehra Dun. The beetles responsible for the damage were identified as *Lyctus africanus* and *Heterobostrychus æqualis*. The Forest Entomologist advised the factory regarding remedial measures.

The attack by the teak defoliators *Hyblæa puera* and *Hapalia machæralis* was very severe this year especially in Mandla, Yeotmal and Nagpur, which resulted in a very poor seedling. As the prevalence of these pests appears to be increasing in the province, and as the indirect financial loss caused by them is estimated to be very considerable, the results of experiments at Nilambur, where some insects which live parasitically on the caterpillars of these defoliators are being introduced from Burma; are of interest to this province. If successful, similar experiments are to be started in a secluded and closely confined area of the provinces.

## II.—ZOOLOGY.

A general increase in the number of does and hinds especially in sanctuaries is reported from most divisions and also in the amount of damage these animals do to forest seedlings by browsing.

## NORTH-WEST FRONTIER PROVINCE.

## INSECT PESTS.

*On blue pine.*—For some years past stray saplings of blue pine have been dying near Naddi in the Lower Kagan range. The cause of death has now been determined by the Forest Entomologist as a weevil, *Hylobius angustus*, the larva of which attacks

the stem at soil level and girdles it under the bark. The Forest Entomologist reports that this insect characteristically attacks plants which are bent at the base by snow pressure or soil creep, as well as those injured at the base by rolling boulders or fallen trees. There appears no danger of the attack reaching serious dimensions and stray casualties will have to be accepted as a matter of course. Attacked stems should be removed and the weevils destroyed.

*On chir.*—Grasshoppers did considerable damage to newly germinated chir seedlings on sown patches in the Batrassi regeneration area. The damage was partially checked by means of Paris green and lead arsenate.

Considerable damage was caused over about 1,000 acres of chir forest (mostly guzara) in the Lower Siran range by a defoliating caterpillar which has yet to be identified. Such attacks are rare on chir, though the local people say the same area was affected about twenty years ago.

## CHAPTER V.

## UTILIZATION AND ECONOMIC RESEARCH.

## ASSAM.

## I.—GENERAL WORK OF ADMINISTRATION.

Mr. S. M. Deh held charge of the post of Forest Utilisation Officer during the year under review.

## II.—EXPERIMENTAL ACTIVITIES.

(1) *Wood technology.*

(a) *Semul (Bombax malabaricum)*.—There is a popular belief, based on the two distinct colours, viz., “yellowish-brown” and “white” in which the wood occurs, that there are two varieties of *semul* in the Brahmaputra Valley.

Results of the study of various specimens indicate that the yellowish-brown wood is generally derived from trees stunted, slow in growth and growing on such hill slopes and grass lands as are exposed to frequent and fierce fires, whereas trees growing in suitable places and of faster growth yield the white timber which is coarser-grained and softer.

(b) *Collection of authentic wood specimens for anatomical study at the Forest Research Institute, Dehra Dun.*—Specimens of 183 species are wanted of which about one-third have been supplied and collection of the rest is in rapid progress.

(2) *Timber seasoning.*

Our activities to improve the quality of indigenous timber by checking degrade that develops in unseasoned wood and thus to increase the demands, by remedying, as far as practicable, the general complaint of users in regard to the scarcity of seasoned stuff, have aroused the interest of timber dealers who, except those of little capital, have erected seasoning sheds. It appears that it will be some time before the doctrines of clean timber yards and depôts and of the stacking of materials for air seasoning are rightly served.

(3) *Timber testing.*

Many consumers seem to possess some empirical knowledge about the differences in strength and durability of our sal from various localities, which influence variation in prices. It was therefore thought essential to support a proposal for the strength and durability tests of sal to be carried out by the Forest Research Institute, and a resolution to this effect was passed at the Utilisation Conference held at Dehra Dun in March 1937.

(4) *Wood preservation.*

Necessity for a suitable preservative for inferior woods and bamboos is being realized, and Ascu would have been highly appreciated had it been made locally available at prices compatible with the purchasing capacity of the prospective users of treated materials.

A comprehensive statement giving the information required under paragraph 32 of the Raman Committee Report was prepared and submitted for transmission to the Railway Board. Forty-five merchantable timber species were dealt with.

(5) *Woodworking.*

(i) The following species were supplied to the Gramophone Company of Dum-Dum, Calcutta, for cabinet-making tests:—

*Toon* (*Cedrela toona*).

*Paroli* (*Stereospermum chelonoides*).

*Gunseroi* (*Cinnamomum glanduliferum*).

*Gendhelipoma* (*Dysoxylum hamiltonii*).

*Sam* (*Artocarpus chaplasha*).

*Ping* (*Cynometra polyandra*).

*Kurta* (*Palaquium pollyanthum*).

*Mahi-thejera* (*Carallia integerrima*).

Including twelve of last year, the quantity of samples sent comes to twenty species. The following is an extract from the report from the Cabinet Factory Superintendent of the Company:—

“ . . . . . we have now selected two species of timber from the samples sent to us which we anticipate will be suitable for small Gramophone cabinets, *bansum* and *titachump*.”

(ii) *Shuttles*.—No report has yet been received on the samples of *ajhar* (*Lagerstræmia flos-reginæ*) and *bonsum* (*Phæbe goalparensis*) sent last year to Bombay. A local cottage industrialist is using the latter wood with success for the manufacture of shuttles for hand looms.

(iii) *Bobbins*.—Samples of *sam* (*Artocarpus chaplasha*), *haldu* (*Adina cordifolia*), *rhokan* (*Duabanga sonneratioides*), *bola* (*Morus lævigata*) *ajhar* (*Lagerstræmia flos-reginæ*) and *bonsum* (*Phæbe goalparensis*) were sent to a firm in Calcutta for test. No report is yet to hand.

(iv) *Umbrella handles*.—Of five samples of timber supplied to the Bharat Industries Corporation, Howrah, the following three were found satisfactory:—

*Bonsum* (*Phæbe goalparensis*).

*Titachapa* (*Michelia champaca*).

*Gogra* (*Schima wallichii*).

(v) *Tool handles*.—A log of *ping* (*Cynometra polyandra*) has been sent to the Indian Turpentine and Rosin Company's Factory at Clutterhuckganj, Bareilly, for tests for industrial purposes.

(vi) *Seating accommodation for the Assam Legislative Chamber*.—*Amari* (*Amoora wallichii*) for legs has been successfully used by the supplying firm, the Don Bosco Industrial School of Shillong, and birch wood (*Betula alnoides*) for other parts of seats and desks.

(vii) "*Chesses*" for the use of *Sappers and Miners units*.—The Superintendent, Gun Carriage Factory, Jubbulpore, was supplied, on payment, through a contractor, with his requirement for a small quantity of *bonsum* (*Phæbe goalparensis*) passed by the Utilisation Branch.

#### (6) *Match wood*.

Samples of eleven species consisting of those mentioned in the last year's report and of *Hymenodictyon excelsum* and *Polyalthia simiarum* were sent for investigation to the Assam Match Company's Factory at Duhuri, which has not yet been able to carry out the test owing to a labour strike.

#### (7) *Woods for packing cases*.

A firm of Newcastle, Australia, wanted a light white odourless timber that will not taint butter and will stand up to nailing for butter boxes. *Bhelu* (*Tetrameles nudiflora*) was suggested to

them who were also put in touch with the Surma Valley Saw Mills with necessary instructions to the latter for the supply of a sample consignment, which is reported to have been despatched very recently.

Samples of the following woods were sent to the Venesta Factory, Kamarhati, with a view to investigating the possibility of manufacturing tea chest battens:—

*Hollong* (*Dipterocarpus macrocarpus*).

*Simul* (*Bombax malabaricum*).

*Bhelu* (*Tetrameles nudiflora*).

*Hollong* battens are used for the same purpose by the Assam Railways and Trading Company's Veneer Mills at Margherita with success, and the fact was intimated to the Manager of the Venesta Factory. But it is interesting to note the influence of tradition, as has been made clear in a letter from him which is reproduced below:—

“ We are in receipt of your letter of the 16th instant, together with the sample tea chest battens for which we thank you.

Since we took up this matter with you we have been given to understand by our London office that it is feared our tea chest customers having for so long been accustomed to the use of a white pine batten, would look with disfavour and perhaps suspicion on any other kind of wood that did not have the same white appearance.

The samples you have submitted to us fall considerably below this standard so we are afraid they will not suit our purpose, particularly the *hollong* which is quite red.

We shall be glad to hear whether you are able to supply any other kind of timbers more in line with our existing pine batten, a sample of which we have already sent you.”

#### (8) *Plywood and veneers.*

A list showing the varieties of timber suitable either for commercial white plywood or decorative veneer wood with approximate cost per ton at Calcutta, was prepared and submitted to the Forest Economist, Dehra Dun. Eleven species were suggested for white plywood for boxes, containers and utility work and for cores for laminated stock, and seven for decorative plywood and ornamental veneers, laminated panels, furniture, etc.

(9) *Paper pulp.*(a) *Bamboo.*

A preliminary enquiry shows that more than twenty-five varieties of bamboo occur in the Province in large quantities, of which there are only four species that are at present important from the point of view of pulp industry. They are arranged below in descending order of merit as regards the extent of occurrence, annual yield and accessibility:—

*Muli* or *tarai* (*Melocanna bambusoides*).

*Pecha* or *rako* (*Dendrocalamus hamiltonii*).

*Khang* (*Dendrocalamus longispathus*).

*Mirtenga* (*Bambusa tulda*).

The current demand for these materials for the manufacture of paper pulp does not represent even one hundredth part of the output.

(b) *Grass.*

Some species of grass growing in abundance have been found suitable for pulp-making in the laboratory test at Dehra Dun. They are awaiting industrial investigation.

(c) *Wood.*

For mechanical pulp, cheap wood of little value for other utility purposes, may be advantageously tried. Probable timbers found in commercial quantities are:—

*Bombax malabaricum* (of inferior quality).

*Gmelina arborea* (of inferior quality).

*Kydia calycina*.

*Macaranga* spp.

*Sterculia* spp.

*Tetrameles nudiflora*.

It is gratifying to mention here that appropriate resolutions were passed at the Utilisation Conference held in March 1937, at Dehra Dun, to the effect that the Paper Pulp Section of the Forest Research Institute would carry out investigations necessary for the development of the paper pulp industry, with a view to improving the utilisation of these raw materials,

(10) *Minor forest produce.*

*Sati (Curcuma angustifolia)*.—Botanical specimens were supplied to the Forest Research Institute, Dehra Dun, for identification of the species yielding flour (*tikur*) from roots.

*Chaulmugra (Hydnocarpus kurzii)*.—Further orders were received from the Acting Chief, Direccao Dos Services De Agricultura, Colonia De Mogambique, for supplying fresh seeds for test.

*Phagdima (Trema politoria)*.—In continuation of what was stated last year a second sample consisting of uncrushed fibrous bark was supplied to the Assam Oil Company and the following extract from the report on the test of the same, received from the Manager, may be of interest:—

“ . . . . . Our Field Chemist writes as follows:—

In the laboratory *Trema politoria* gave good results in the mud treatment. It proved difficult, however, to prepare it in the form most useful for the work it was intended for, *i.e.*, in fibres 1" long. This difficulty has not yet been overcome and we should welcome any suggestions you may wish to make in this connection. We should be glad to learn the approximate cost of the prepared, uncrushed bark.”

*Pishachban (Eupatorium odoratum)*.—Flower and stem specimens were sent to Dehra Dun for essential oil test and the Biochemist writes as follows:—

“ The flowers and stems of *Eupatorium odoratum* arrived here in very dried condition and gave on distillation, only traces of the essential oil. It appears that the oil has been lost during transit and drying. I shall be obliged if you will kindly send, when available, freshly plucked flowers only (3-5 mds.), and slightly air dried before despatch, to prevent their decomposition during transit.”

*Bakhal bih (Derris species)*.—Samples of *Derris* root were sent for valuation to two firms in England and Messrs. Cooper McDougall & Robertson, Ltd., of Berkhamsted, report as under:—

“ We thank you for your letter of the 30th April, and for the samples of *Derris* root which you forwarded to us.

We find on analysis that the sample is very low in ether extract and of little commercial value, although it contains a good proportion of rotenone in comparison with the ether extract.

Good grades of commercial *Derris* may contain up to 25 per cent. of extract and 10 per cent. rotenone, and in view of the fact that the sample you forwarded contained less than 5 per cent.

extract it would not be a commercial proposition for us to consider the importation of this material."

Since receipt of this report, doubt has arisen as to the identity of our *Derris* and the Botanical Officer has been requested to examine further.

*Bakhal bih (Millettia pachycarpa)*.—Samples of root were sent to Dehra Dun with request for preliminary test and the following report from the Forest Economist is interesting:—

"The sample of roots of *Millettia pachycarpa* sent along with your above quoted letter has been analysed by the Bio-chemist with the following results:—

	Per cent.
Moisture in air dry roots . . . . .	11.9
Crystalline substance . . . . .	0.75
Resinous substance . . . . .	1.69
	<hr/>
Total ether extract . . . . .	2.44
	<hr/>

The crystalline substance (melting point 163°-164°) has been identified as rotenone, the active insecticidal principle of *Derris*. The above result is interesting and at the same time important, as it adds one more species of plant, of Indian origin, to the list of only a few species of plants in the world, which contains this important insecticidal principle.

The rotenone content of plants varies with the locality and age of the plant. This has been noticed in the case of *Derris elliptica* growing in Assam. It is, therefore, desirable that roots of *Millettia pachycarpa* growing in different localities in Assam and collected from plants of different age (below 18 months, 18-24 months and above 24 months) should be examined for their rotenone content, and I should be thankful if you would arrange to send me the above mentioned samples for further examination by the Bio-chemist. About 5 lbs. each of completely air-dried roots will be sufficient . . . . ."

*Leaves for wreath-making*.—Specimens of leaves from the following species were supplied to the British Legion Poppy Factory, Surrey:—

*Mesua ferrea*.

*Michelia champaca*.

*Michelia philocarpa*.

*Pachylarnax philocarpa*.

*Ficus* spp.

The Works Manager of the firm has kindly agreed to treat them and to send a report in due course.

*Gandhi (Homalomena rubescens)*.—In continuation of what was stated last year the following extract from a letter from the Department of Pharmacology, School of Tropical Medicine, Calcutta, will be of interest:—

“ An essential oil has been isolated from *Homalomena rubescens* roots and it is being worked up. The amount of the oil obtained from the roots, however, is rather small and we shall be greatly obliged if you could send about 20 seers more of the roots to complete the investigation.”

Twenty seers of roots were supplied before the close of the year.

*Ahoi (Vitex peduncularis)*.—In continuation of last year's statement, the report from the School of Tropical Medicine, Calcutta, is quoted below:—

“ *Vitex peduncularis* was analysed and did not show the presence of any active principle. Small traces of an alkaloid were found; the quantity, however, was so small that further investigations were not possible. It has also been tried clinically at our school but not found to be useful in Malaria. If, however, you could send us about 20 seers of quite *young* leaves, dried in shade, we shall be glad to investigate it further.”

Twenty seers of young leaves were in process of collection at the end of the year.

*Sia nahor (Kaya assamica)*.—Twenty seers of entire fruits of *sia nahor* were sent to the Forest Economist, Debra Dun for preliminary examination by the Bio-chemist.

*Leluk (Beilschmiedia roxburghiana)*.—Forty lbs. of bark were sent to Dehra Dun for analysis by the Bio-chemist. The hill tribes of the North-East Frontier tracts attribute to this bark properties for healing chest and lung troubles.

*India rubber (Ficus elastica)*.—Mixed with Para rubber it makes a good article of commerce. In the process of sheet-making it appears to be more expensive than other varieties of rubber in the market. It has successfully stood the manufacturing trials made by the Premier Rubber Works, Ltd., at their factory at Narikeldanga, Calcutta.

*Gutta percha (Palaquium polyanthum)*.—Fifteen seers of latex were collected by tapping some trees and samples distributed to several prospective dealers. In this connection, a letter from

Messrs. India Rubber Gutta Percha and Telegraph Works Co., Ltd., Calcutta, is quoted below:—

“Thank you for the parcel containing 2 lbs. of raw *gutta-percha*. I propose forwarding this sample to our works in England, but should be obliged if you would please advise what quantities are available and the approximate price delivered Calcutta.

We notice that this *gutta-percha* has already undergone some primary cleansing process, and as our supplies from West Africa are of a much rougher and dirtier type the prices of the two types would be appreciated, as in the cleansing and pressing process all dirt can be eliminated without extra cost.”

They have been supplied with the information asked for, except that no definite statement has been made in regard to prices of which we have little knowledge at the moment. They have been requested to quote what they could offer. From subsequent correspondence it is understood that the Manager has sent the sample to their London Office for valuation.

An explanation as to the “cleansing process” mentioned in the above quoted letter may be of interest. No attempt was made to clean the stuff. The latex when collected fresh was in thin liquid condition free from superficial dirt, and after some days the watery portion became normally separated leaving a very soft plastic residue to settle at the bottom of the container. It is from this residue that the sample was sent.

### III.—COMMERCIAL ACTIVITIES.

#### (1) *Timber Trade.*

##### (a) Supply of Timber to Railways.

##### (1) *Sleepers*—

*Nahor (Mesua ferrea).*—A complaint has of late been received in regard to the scarcity of good quality sleepers of *nahor*, which has long satisfied the requirement of the Dibru-Sadiya Railway. This question is under investigation.

##### (2) *Timbers other than sleepers*—

*Purchasers' Agency.*—Twenty-five tons of *sissoo (Dalbergia sissoo)* in logs, and about four hundred tons of converted material mostly from *bonsum (Phaebe goalparensis)*, *amari (Amoora wallichii)* and *titachapa (Michelia champaca)* were supplied to the Assam Bengal Railway, and about fifty tons of mixed woods to the Tospur Balipara Railway.

## (b) General.

*Internal consumption.*—Use of woods including plywood tea chests by the two local veneer mills is steadily increasing.

*Export.*—There was no lack of animation in the export trade as well.—Export amounted to about thirty thousand tons of woods consisting mainly of:—

Sal (*Shorea robusta*).

Sam (*Artocarpus chaplasha*).

Ajhar (*Lagerstræmia flos-reginæ*).

Amari (*Amoora wallichii*).

Bonsum (*Phæbe goalparensis*).

Gurjan (*Dipterocarpus pilosus*).

Titachapa (*Michelia champaca*).

Gogra (*Schima wallichii*).

Simul (*Bombax malabaricum*).

Bhelu (*Tetrameles nudiflora*).

## (2) Trade in minor forest products.

*Bamboos.*—Consumption by the Indian Paper Pulp Company has not increased but the demand from the adjacent districts of Bengal for domestic use, indicates slight improvement. The umbrella handle industry seems to have recovered from the setback caused by the general trade depression.

*Grass.*—Because of the extensive use of corrugated iron sheets, the demand for thatching grass has decreased especially in Upper Assam. In the Surma Valley and Lower Assam there is still a good market for it.

*Lac.*—The growers are not getting the true value for their crop owing to the intervention of middlemen in the trade.

*Cane.*—The market was steady.

*Rubber (Ficus elastica).*—A *mahal* was created for the whole of the Province and farmed to the Premier Rubber Works, Ltd., for 3 years for a monopoly fee of Rs. 700 in addition to an *ad valorem* duty of 12½ per cent. to be paid on the materials collected.

*Pipul (Piper longum).*—The market had a steadier tone.

*Honey.*—Price changes moved to higher levels.

*Bee's wax*.—Market was active with prices indicating tendencies to move in buyers' favour.

*Herbal drugs*.—There was an animated market for *raktachita* (*Plumbago rosea*), but the supply was very poor. A new addition was *Polypodium* fern which is used by an apothecary of Manipur State for a proprietary preparation.

*Chaulmugra* seeds (*Hydnocarpus kurzii*).—Neither the production nor the price was up to expectations.

*Agar* (*Aquilaria agallocha*).—There was a very strong market. There are many grades in which this luxury wood appears before the users. Prices for the top qualities reached the pre-slump peak levels, viz. :—

Quality I.—Rs. 500 to Rs. 600 per *maund*.

Quality II.—Rs. 300 to Rs. 400 per *maund*.

Quality III.—Rs. 100 to Rs. 250 per *maund*.

"*Dhum*" is a general term for all the inferior qualities which also have a different classification. *Dhum* sold for Rs. 20 to Rs. 80 per *maund*.

*Agar* oil sold for Re. 1-4 to Rs. 2 per *tola* (approximately 2/5 oz.).

*Elephants*.—444 animals were captured, of which 1 died and 14 were shot in stockades, 131 released, 6 given to the capturers on payment of royalty and 292 sold. Average price received was Rs. 573 per head, which was not at all unsatisfactory in view of the increasing motor traffic and inflated supply of elephants.

*Lime stone*.—Owing to the growing competition from cement the use of lime is decreasing with deterrent effect on the development of business in lime stone.

*Rhinoceros skins, horns and hoofs*.—Four horns, weighing 322 *tolas*, were sold for Rs. 3,205, or Rs. 9-15-3 per *tola*, or Rs. 398 per lb. Ten hoofs weighing 43 oz. fetched Rs. 25-2, or Rs. 9-5 per lb., and one skin weighing two *maunds* Rs. 300 or Rs. 14 per lb.

*Ivory*.—Twelve *maunds*, twenty-three *seers* and twelve *chittacks* of found and confiscated elephant tusks were sold by auction for Rs. 5,368 or Rs. 10-10-6 per *seer*.

### (3) *Railway and steamer freight.*

*Elephants*.—As a result of further discussion with the Traffic Manager (Commercial), Assam Bengal Railway, the rates for full

grown elephants has been reduced from 12 annas a mile to 8 annas a mile with effect from December, 1936, in booking over the Assam Bengal, Eastern Bengal and Cooch Behar State Railways, which is really a substantial concession. Had it not been partly for this concession and its predecessor mentioned in last year's report, and partly to improved financial conditions, it would have been difficult to obtain such prices for elephants as were realized during the year.

*Agar (Aquilaria agallocha).*—Station to station rates for *agar-wood* including “*dhum*”, which are 33 per cent. less than the usual, were introduced by the Assam Bengal Railway. This concession has afforded a great stimulus to the trade of *agar* in general and “*dhum*” in particular, with the consequential keener demand for *agar mahals*.

These reductions of freight have not only benefitted the trade in *agarwood* and elephants but also the Railways by increasing the traffic. There are many other commodities which, with sympathetic consideration from the transporting agencies, will be of immense service and good for them as well as for the producers, distributors and consumers.

A list was prepared showing the weight per cubic foot of dry and raw wood of various species of commercial timbers of Assam and submitted to the Traffic Manager (Rates, Development and Publicity), Eastern Bengal Railway.

#### (4) *Publicity and Propaganda.*

(i) For the encouragement of a wider use of timbers only little known, a consignment of *gogra* (*Schima wallichii*) scantlings was sent through a merchant firm to Bikrampur, which is a very big consuming centre for timbers and sold at low prices which were tempting to the buyers.

(ii) With a view to extending their use, attention of wood-workers in general and furniture-makers in particular was, wherever possible, directed to the actual use of *amari* (*Amoora wallichii*), *haldu* (*Adina* spp.), *hollock* (*Terminalia myriocarpa*), *boga-poma* (*Chukrasia tabularis*), *poma* (*Cedrela* spp.) and *sam* (*Artocarpus chaplasha*) in accessible places.

(iii) Arrangements were made with the Officer-in-charge, Commercial Museum and Publicity Department, Corporation of Calcutta, for exhibiting samples of our forest products in the Com-

mercial Museum and for giving proper publicity to them. To start with the following samples were supplied:—

- (1) A small hullock cart made of ivory.
- (2) Some crude Indian rubber.
- (3) Eight kinds of *agorwood*, including *dhum*.

(iv) Mention was made in the last year's report, of the improvement effected in regard to the market for sal logs at Sapotagram, the biggest sale depôt in the Province. The next important depôt is Kukurmara, where there was a glutted market for the last two years, because of the lack of transporting facilities arising from a shoal formed at the confluence of the Kulsi River with the Brahmaputra.

The course of the Kulsi River was examined from Kukurmara to the Brahmaputra River. The purchasers as well as the boatmen were advised as to the means of tiding over occasional backflows with the help of sails when wind would blow favourably, so as to enable them to extract logs cheaply. They had also been given an assurance of safety before they could be persuaded to launch upon a risky undertaking. These efforts more than fulfilled expectations.

(v) A formula for curing, cleansing and preserving the enamel of elephant tusks was adopted. It not only served these purposes well but also prevented loss in weight to a large extent as has been noticed in the case of freshly extracted tusks. The high average price of Rs. 10-10-6 per seer of ivory obtained in the last sale against Rs. 9-8-6 in the previous one, is attributable to the improvement in quality resulting from the treatment accorded to the material and also to the wide publicity of the sale.

#### (5) *Miscellaneous.*

1. *Departmental sleeper supply.*—With the object of helping the Assamese contractors of slender capital, who are in danger of being squeezed out of business, a triennial contract for the supply of 50,000 metre gauge sal sleepers per year was secured from the Eastern Group of Sleeper Control. At the very outset they showed great earnestness which took no time to decline owing to lack of the requisite funds. Necessary advice in the matter of even finance was not denied. In short the Department left no stone unturned to help them and its efforts were highly appreciated in the press (*vide* the *Biweekly Assamiya*, dated the

31st March 1936). But ultimately they failed to fulfil expectations; only 5,576 sleepers were supplied by them, and the balance was made up from other sources.

2. *Supply of samples*.—Requests for specimens were complied with, and samples intended for commercial and industrial investigation liberally distributed.

3. *Utilisation conference*.—The writer of the report took part in the Utilisation Conference held at Dehra Dun, March 17th-20th, 1937.

4. *Commercial timbers*.—A list showing the commercial timbers of Assam was prepared, as a preliminary to a Hand-Book of Forest Products of Assam.

5. *Enquiries*.—Various enquiries were answered on timber, bamboos, cane, lac, *agarwood*, Indian rubber, resin, honey, bee's wax, fish-poisons and drugs.

6. *Liaison*.—The usual liaison was maintained with the provincial Silviculturist and Botanical Officer; Specialists at the Forest Research Institute, Dehra Dun; Director of Commercial Intelligence and Statistics, Calcutta; Director, School of Tropical Medicine, Calcutta; the Officer-in-charge, Commercial Museum and Publicity Department, Corporation of Calcutta; and the Cabinet Factory Superintendent, the Gramophone Company, Limited, Dum Dum. Acknowledgments are due for help from all these sources.

7. *Forest Products Museum*.—Samples of raw materials of forest origin and also of products manufactured therefrom are being collected for display with a view to encouraging the public to buy indigenous products. In short, the Museum will serve the purpose of not only a show-room, but will also pave the way for marketing.

8. *Aims and Achievements*.—It appears that some sections of the public are not acquainted with the aims and objects of the Utilization office.

The primary object is to develop the utilization of all the natural resources of our forests, to stabilize prices throughout the province, and to place an increasing supply of marketable products within the reach of the public.

## BENGAL.

### UTILIZATION.

#### I.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Utilisation Officer, Bengal, was held by Mr. W. E. Hodge, D.C.F., from 1st April 1936 to 24th October

1936, and by Mr. C. T. Trigg, D.C.F., from 25th October 1936 to 31st March 1937. The number of days spent on tour by each were:—

Mr. Hodge, D.C.F., 62 days.

Mr. Trigg, D.C.F., 29 days.

The headquarters of the Forest Utilisation Officer, Bengal, were moved from Darjeeling to Calcutta in June 1936. The office of the Forest Utilisation Officer, Bengal, was closed in Darjeeling on 20th May 1936 and reopened on 25th May 1936 at Alipore, Survey Building.

During the year under report the Forest Utilisation Officer, Bengal, was still understaffed, with no funds available for expansion and advertisement. With one temporary clerk and no money, research and enquiry were limited, as the office was fully occupied in dealing with outside enquiries and tenders, and had to make shift with the means at its disposal.

## II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

Unfortunately there has been a falling off in supplies of miscellaneous timbers other than sal (*Shorea robusta*), and *gurjan* (*Dipterocarpus turbinatus*), Divisional Forest Officers being unwilling, and in most cases unable, to supply, especially at current market rates.

In many cases it was not realised early enough that the timbers we were trying to market were not available in sufficient quantities to make marketing an economic proposition.

We have definitely had to avoid canvassing for orders for timbers in the log, other than sal (*Shorea robusta*), *gurjan* (*Dipterocarpus turbinatus*), *sundri* (*Heritiera* spp.) and *civit* (*Swintonia floribunda*).

Sissoo (*Dalbergia sissoo*) is in fair quantities but we cannot guarantee the logs, and the Divisional Forest Officer, Buxa division, states that the best way to sell would be sawn, and that he is not prepared to offer in the log.

Sissoo (*Dalbergia sissoo*) has not been enumerated. In fact for none of the timbers other than sal (*Shorea robusta*) and *sundri* (*Heritiera* spp.) have we accurate outturn figures. But even without enumeration it can be safely said that our stocks of any one good quality timber, with the exception of sal (*Shorea robusta*) in the north and *gurjan* (*Dipterocarpus turbinatus*) in the south, are very limited.

Timbers are being sent for test to the Forest Research Institute, Dehra Dun, but good reports are handicapped by lack of supplies. The public do not realize our unfortunate situation and from enquiries it appears that they have very erroneous idea of the stocks in our forests. That we have had to refuse orders has been a great disappointment and very discouraging, and tends to get the Department a bad name.

Tests made at the Forest Research Institute, Dehra Dun, are frequently of immediate value, but they are of much more value in our efforts to predict the future, and so guide us in our plantation work.

#### (1) *Wood technology.*

A key for the identification of 34 Bengal timbers is being prepared at Forest Research Institute, Dehra Dun. Divisions are sending specimens.

#### (2) *Timber seasoning.*

(i) *Cedrela toona*.—10 tons of forest grown toon (*Cedrela toona*) were sent to Dehra Dun for kiln-seasoning tests for comparison with road-side toon. No report has yet been received.

(ii) *Terminalia tomentosa*.—2 logs of laurel (*Terminalia tomentosa*) were kept stored in water for experimental seasoning purposes for a year in Buxa division. After the year, one was found so badly split that it was useless for sawing. The other was perfectly sound and was sawn up into planks and scantlings the behaviour of which is being watched. Splitting of the first log may be due to internal cracks caused when it was felled, though these were not apparent at the time.

#### (3) *Timber testing.*

(i) No report on the logs of the following species sent to Dehra Dun, Forest Research Institute, during the year 1934-35 for test on project VIII was received:—

<i>Castanopsis hystrix</i>	. . . .	Darjeeling.
<i>Terminalia tomentosa</i>	. . . .	Kurseong.
<i>Anthocephalus cadamba</i>	. . . .	Do.
<i>Artocarpus chaplasha</i>	. . . .	Chittagong Hill Tracts.
<i>Gmelina arborea</i>	. . . .	Ditto.
<i>Lagerstræmia flos-reginæ</i>	. . . .	Ditto.
<i>Michelia champaca</i>	. . . .	Ditto.
<i>Dipterocarpus turbinatus</i>	. . . .	Ditto.

(ii) *Grewia tiliaefolia* and *Grewia vestita*.—Samples of the above species were sent to the Forest Research Institute, Dehra Dun, in

1934-35 for comparative tests from Kurseong. No report has yet been received.

(iii) *Gmelina arborea*, 4 logs.

*Artocarpus chaplasha*, 4 logs.

*Dipterocarpus* spp., 4 logs.

*Michelia champaca*, 4 logs.

Reports on the above logs sent from Chittagong Hill Tracts division to the Forest Research Institute, Dehra Dun, for general quality tests in 1934-35 have not been received.

(iv) *Tectona grandis*.—The following reports were received from Dehra Dun on the teak (*Tectona grandis*) sent from Chittagong Hill Tracts and Kurseong divisions.

Both these consignments have now been completely tested and a table of strength results giving also the strength of Burma and Malabar teak is attached (not included in this report). All values for air-dry tests have been reduced to a uniform moisture content of 12 per cent. for easy and accurate comparison.

Two of the teak trees from Kurseong division were suspected of fungus attack from the appearance of black and brown stain. Doubtful specimens were sent to the Wood Technologist for microscopic examination who reported that they were heavily attacked by fungus. But as their strength figures did not show any deterioration and compared well with those for other trees they have been included in the averages. Broad dark streaks were found in all trees of this consignment. It may be interesting to investigate if it is a characteristic of teak grown in Kurseong division.

Kurseong teak is on an average slightly lighter than Chittagong Hill Tracts teak being 38 lbs. per cu. ft. while the latter is 40 lbs. and although it was suspected of fungus attack, was slightly superior in strength to the latter. The difference between them was however very small. They are therefore combined together under the name of Bengal teak.

*Bengal teak*.—The specific gravity of Bengal teak (average of Kurseong and Chittagong teak) is .56, i.e., about 9 per cent. lower than Burma and Malabar teak. Its average weight at 12 per cent. moisture content is 39 lbs. per cubic foot. It is about 10 per cent. lower in modulus of elasticity and modulus of rupture and about 20 per cent. lower in elastic limit, compression and hardness. But it withstands a considerably higher Max. drop in Impact bending. It has also a slight advantage over Burma and Malabar

teak in having a somewhat lower shrinkage, making it more suitable for furniture.

Bengal teak offered no conversion difficulties except slight gumming of saw-teeth and knife edges, as in the case of all teaks. It machines well, turns well and can be brought to a fine smooth surface by hand without any difficulty. It takes a good spirit polish.

(v) *Ailanthus grandis*.—A specimen log of this species was sent to the Forest Research Institute, Dehra Dun, in 1934-35, from Buxa division, for tests under project I. No report has yet been received.

(vi) *Swintonia floribunda*.—A veneer test report on *Swintonia floribunda* was received from the Forest Research Institute, Dehra Dun, as follows:—

There was every indication that *Swintonia floribunda* would make up into a useful second class plywood but it would have to be processed immediately after felling to avoid damage by insect and fungus.

The timber might be suitable for the match industry provided factories could get supplies free from insect and fungus attack.

Weight of the wood at 12 per cent. moisture content 38 lbs. per cubic foot.

(vii) *Carapa moluccensis*, *Avicennia officinalis*.—2 logs of *bœn* (*Avicennia officinalis*) and 6 logs of *pussur* (*Carapa moluccensis*) have been despatched to the Forest Economist, Forest Research Institute, Dehra Dun, for testing their working qualities and for the manufacture of plywood panels from the Sundarbans division.

(viii) *Cryptomeria japonica*—*Bucklandia populnea*.—The following reports were received from the Forest Research Institute, Dehra Dun, on the above timbers:—

“ Trade and other names:—Bengal—*pipli*, Assam—*dingdah*.

Habit and distribution:—A large tree with a straight cylindrical stem. Found in the Eastern Himalayas in Darjeeling and Kurseong divisions and in the Khasia Hills of Assam.

Characteristics:—Light reddish brown, lustrous having particularly pleasing effect when peeled, inclined to be interlocked but not sufficient to interfere with its conversion into veneers by the rotary method.

The consignment under review appeared to be fast grown. It had very little sapwood and there was evidence of the fact that this species is subject to attack by pinhole borers. A sweet odour

was noticed while the timber was green, but this faded out during the drying process.

Supplies:—Supplies appear to be limited, records showing that conjointly the Darjeeling and Kalimpong divisions can supply only about 130 tons per year. This figure would not qualify the establishing of a factory for conversion of *pipli* alone. It could, however, be used in conjunction with other timbers for the manufacture of plywood.

Boiling and peeling:—This species offers little or no difficulty during the peeling process and subsequent manufacturing stages. In fact it is a pleasure to convert and fabricate, very sound continuous tight veneers being obtainable without resorting to previous boiling treatment or special machine technique.

Strength (Static bending):—Average maximum load 85 lbs.

Glue adhesion:—Average 205 lbs. per square inch.

### Summary.

*Bucklandia populnea* is a very suitable timber for manufacture of a second grade utility plywood and is worthy of further consideration. Due, however, to the possibility of attack of pinhole borers this species should be converted and dried very soon after felling.

*Pipli* plywood can be filled, painted, varnished or polished to a finish suitable for interior fittings, ceilings shop and office fittings, partitions and many other kinds of work.

As stated above the drawback would appear to be the obtaining of supplies in commercial quantities as a result of which it would be necessary to use *pipli* in conjunction with some other suitable species."

*Cryptomeria japonica*.—Test Nos. 139 and 142.—"Due to its exceptionally rapid growth (average 3 rings to the inch) it was found impossible to produce veneers of *Cryptomeria japonica* from Bengal under any circumstances.

Grown in Japan, *Cryptomeria japonica* lends itself to being made up into a reasonably good second grade plywood. Unless the Bengal variety can be considerably slowed down in its growth it cannot be recommended for manufacture into plywood."

(ix) *Michelia champaca*.—The following report was received on the *champ* (*Michelia champaca*) planks supplied from Buxa division to Ishapur Rifle Factory during the year:—

"The results of the trials of the three chests with fittings have shown that whereas the timber *champ* is suitable for the repair of

chests S. A. at bottoms and ends, it is unsuitable for the repair of chests S. A. at lids and sides, owing to the tendency of splits and breaks appearing at crew holes, and it is unsuitable for the manufacture of fittings to chests owing to its being too brittle and easily broken.

It has therefore been decided not to proceed further with the use of this timber."

(x) *Cedrela febrifuga*, Blume—*Cedrela toona*, Roxb.—Two pieces of hill *toon* (*Cedrela febrifuga*, Blume) and two pieces of plains *toon* (*Cedrela toona*, Roxb) were supplied to the Ishapore Rifle Factory from Kalimpong division for making machine gun chests. The plains *toon* was found suitable for their requirements.

(xi) *Sal* (*Shorea robusta*)—Black *siris* (*Albizia odoratissima*)—Bishop wood (*Bischofia javanica*).—The following reports were received from the North-Western Railway during the year under report:—

"About 6,000 R. ft. of cornice mouldings were cut from *sal*, black *siris* and *bishop wood* and were supplied to them during the year 1934-35. After seasoning for about six months, the timbers were machined and stored in their machined timber shed. Only about one-third of the quantity mentioned was eventually found to be useable, owing to the timbers having twisted and warped. They report that the black *siris* was found unsuitable for railway coach work."

(xii) *Lagerstræmia flos-reginæ*.—The following report was received from the Forest Economist, Forest Research Institute, Dehra Dun, through the Divisional Forest Officer, Silvicultural division, on *Lagerstræmia flos-reginæ* from Chittagong and *Lagerstræmia hypoleuca* from the Andamans:—

"From the tests carried out there seems to be no difference of any practical importance between *Lagerstræmia hypoleuca* from the Andamans and *Lagerstræmia flos-reginæ* from Chittagong. The former is, however, slightly weaker in compression and hardness. Both of them have been grouped together under the name of "jarul" in the official list of trade names."

(xiii) *Swintonia floribunda* (civit)—*Sterculia alata* (gorok).—Two logs of *civit* and *gorok* were supplied to the Western India Match Co., Calcutta, from Chittagong Hill Tracts division, for testing their suitability for match manufacture or any other purpose. The following report was received from the firm:—

"The result of our trial with *civit* and *gorok* for match wood has not turned out satisfactory.

*Civit* can be peeled for splints but is rather hard veneer, surface uneven. The quantity supplied was too small for complete test, but from what has been seen in the peeling process, we are not in favour of using this species.

*Gorok* is entirely unsuitable on account of its hardness. It cannot be peeled.

Both the species are heavy and therefore hardly suitable for case-boards."

(xiv) *Avicennia officinalis* (bæn).—Ten tons of bæn logs were supplied to the Gramophone Company, Dum Dum, for experiment in making gramophone boxes, but it was found unsuitable for the purpose.

#### (4) Wood preservation.

(i) *Acrocarpus fraxinifolius*.—The following report on the durability tests of 200 treated sleepers of *Acrocarpus fraxinifolius* was received from the Chief Engineer, Eastern Bengal Railway, Calcutta:—

Mileage where laid.	Number laid.	Date when laid.	Report on the behaviour of sleepers.
296/5 to 296/8 on the main line between Barsee and Kachna.	200	19th September 1935.	56 Nos.—Good. 134 Nos.—Hair cracks. 9 Nos.—Slight cracks. 1 No.—Big cracks.

The cracks are all longitudinal to the sleepers and appear to be originating from spike holes in some cases.

#### (5) Minor forest products.

(i) *Gurjan oil*.—Tapping of *gurjan* oil departmentally as an experimental measure was continued in the Chittagong division. Different methods have been adopted and it is observed that the flow of oil is scanty during the period from June to October. It is also observed that the hot weather is the only time suitable for tapping. The average outputs of oil for the year by different methods are shown below:—

(1) By local method—5 seers  $4\frac{1}{2}$  tolas per tree.

(2) With lip method—7 seers 15 tolas per tree.

(3) Local methods by local tappers—4 seers  $4\frac{1}{2}$  tolas per tree.

(ii) *Gurjan oil*.—A sample tin of *gurjan* oil was supplied to the Director of Industries, Bengal, from the Chittagong division in

1933-34 for test as to its suitability for paint manufacture but no report has yet been received.

(iii) *Bark of Betula*.—The following results were obtained from the sample bark of *Betula* species after examination at the Forest Research Institute, Dehra Dun:—

Moisture . . . . .	46.8 Per cent.
Essential oil . . . . .	0.08 „

The oil was light greenish yellow in colour and etrongly smelled of winter-green oil. That it contained methylsalicylate was proved by isolating salicylic acid H. P. 154—55° C. But the oil content appears to be too low for profitable extraction of the oil.

(iv) The following were supplied to the Principal, Government School of Dyeing and Printing, Cawnpore:—

Bark of <i>Rubia cordifolia</i> . . . .	Kalimpong.
Bark of <i>Chukrasia tabularis</i> . . . .	Knrseong.
Bark of <i>Ceriops roxburghiana</i> . . . .	Sundarbans.

(v) Specimens of the following were sent to the Biochemist, Forest Research Institute, Dehra Dun, from Kalimpong division:—

<i>Dalbergia stipulacea</i> . . . .	} Bark and roots 10 lbs. of each. Seeds and roots 10 lbs. of each. Twigs and roots 10 lbs. of each.
<i>Entada scandens</i> . . . .	
<i>Millettia pachycarpa</i> . . . .	

(vi) *Grass*.—11 different specimens of grasses were sent to the Forest Research Institute, Dehra Dun, from the Dacca-Mymensingh division. Ten species were identified as:—

- (1) *Eleusine indica*.
- (2) *Eleusine ægyptiaca*, Desf.
- (3) *Eragrostis interrupta*, Beauv.
- (4) *Eragrostis tenella* R. & S.
- (5) *Panicum flavidum*, Retz.
- (6) *Setaria glauca*, Beauv.
- (7) *Digitaria longiflora*, Pers.
- (8) *Eragrostis amabilis*, W. A.
- (9) *Eragrostis stenophylla*, Hochst.
- (10) *Paspalum serobiculatum*, Lin.

The eleventh specimen could not be identified for want of flowers.

#### (6) *Paper pulp*.

(i) Arrangements were made to supply one ton of *gengwa* (*Excæcaria agallocha*) from Sundarbans division.

(ii) One ton of *malata* (*Macaranga denticulata*) timber without bark was sent to Forest Research Institute, Dehra Dun, from Lataguri for mechanical pulp experiments.

(iii) *Mitenga* (*Bambusa tulda*) 5 tons.

*Dolu* (*Teinostachyum dulloa*) 5 tons.

*Kaliseri* (*Oxytenanthera auriculata*) 2 tone.

The above bamboos were sent to the Forest Research Institute, Dehra Dun, during the year 1935-36, from Chittagong Hill Tracts division, for further test of paper pulp, but no report has yet been received.

#### (7) Tans.

The Superintendent, Bengal Tanning Institute, informed us that the five maunds of *goran* (*Ceriops roxburghiana*) bark sent from the Sundarbans division were distributed to different tanners through the Indian Government Trade Commissioner at Hamburg, but none of the tanners was interested.

#### (8) Wood working.

(i) *Swintonia floribunda*—*Sterculia alata*.—Sample logs of the above species from Chittagong Hill Tracts division were supplied to Messrs. Mansfield and Sons, Calcutta. They are interested in *Swintonia floribunda* only and hope to be able to introduce it on the market but the price f.o.r. Calcutta is against it.

(ii) The following examples of timbers were supplied from Kalimpong division:—

(a) Birch (*Betula* spp.) to A. C. Mohamed, Esqr., Calcutta.

(b) Birch (*Betula* spp.) and hill *malata* (*Mallotus nepalensis*) timbers to Messrs. Bharat Industries, Howrah.

(c) *Lampati* (*Duabanga sonneratioides*) planks to Messrs. Mansfield & Sons, Calcutta.

(d) Hill and plains *malagiri* (*Cinnamomum cecidodaphne*) to the Manager, Army and Navy Stores, Calcutta.

(e) *Sundri* (*Heritiera* spp.) to the Calcutta Port Commissioners, for the road way on the Howrah Bridge.

(iii) No report on the specimens of *sal* (*Shorea robusta*) sweepers sent to Ceylon and the Sudan has yet been received.

(9) *Miscellaneous.*

(i) *Pneumatic equipment for bullock carts.*—A cart equipped with Dunlop pneumatic tyres was tried in the Dacca-Mymensingh division for the extraction of poles. The Divisional Forest Officer reported that it was unsuitable owing to the nature of the country.

(ii) The usual liaison was maintained with Divisional Forest Officers, the Timber Advisory Officer to the Railway Board, the Timber Adviser to the High Commissioner, India House, London, and the Forest Research Institute, Dehra Dun.

(iii) We have continued our efforts to get freight rates reduced.

Box and match woods were given all round reductions from Buxa division. *Siris* (*Albizzia procera*) and *udal* (*Sterculia villosa*) were included in the special rates, and *toon* (*Cedrela toona*) was included after the close of the year.

Reduction in the fire-wood rates on the Dacca-Mymensingh division was also secured, and negotiations were continued beyond the close of the year.

Railways and Steamship Companies are generally unwilling to consider reductions in freight unless we can offer considerably increased business, and this is not always possible owing to limited supplies.

## BIHAR.

## I.—GENERAL WORK OF ADMINISTRATION.

The Forest Research Officer, who was also the Working Plan Officer, held charge of the Utilisation Branch. During the year under review he lost the assistance of the Utilization Ranger who was sent to Kolhan division for over six months, and consequently worked under handicap.

## II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

*Grading rules for Timber.*—These rules, compiled last year upon the Empire rules for sawn timber, have now been revised to include Burma teak grading rules for squares, Burma rules for logs, specifications for railway sleepers, and rules for poles based on those drawn up at Dehra Dun for electrical purposes. They thus cover the whole field of timber extraction and sale. Delay has occurred in printing, but they are now to be produced in pocket book form.

*Railway freights.*—Last year substantial freight concessions were obtained for poles extracted from long leads under thinnings schemes in Porahat and Kolhan divisions. This year similar concessions have been granted to stations of Chaibassa division. Representations have also been made for reductions in charcoal freight to Calcutta, and there is reason to believe that these will be successful. The aim is to place all thinning material as poles or charcoal upon the Calcutta or colliery markets from leads of 15-20 miles from the nearest railway stations, or even more in the case of charcoal, leaving firewood to be extracted from the nearer distances.

*Publicity and propaganda.*—It was with regret that we expressed inability this year to take part in the Industrial Exhibition held in Ranchi, owing to the absence of the Utilisation Ranger on whose shoulders falls the task of organising the exhibits. At the Divisional Forest Officer's request, twenty 2' sample planks of commoner Bihar timbers were sent to the Santal Parganas' Agricultural Exhibition. Upon each plank was posted a description of its uses, weight and working qualities. Photographs of the Bihar Ascu white-ant attack experiment were also included.

Towards the close of the year, the Editor of *Industry*, Calcutta, requested an article on Bihar timber for the special July issue which he was devoting to the Wood Industry. This was done. The useful summary on "Seasoning of Timber" from the Burma Hand Book was also sent in, illustrated by the Forest Research Institute poster. With the Forest Research Institute's own valuable extensive contributions, the issue forms a very useful summary of much information hitherto only found scattered in many books, and our Utilisation ledger files will receive much additional information.

*Posters.*—The criticism levelled at the Institute last year for sending to the Patna Exhibition original Utilisation posters, which unfortunately got spoiled by rain, instead of reproducing them by the hundred, for posting up in all Range Offices and timber depôts, has borne abundant fruit. Four extremely useful posters on "Seasoning of timber", "Tool handles", "Treated wood" and "Strengths of Indian timbers" have been produced, and these have been converted in this Province into linen backed wall pictures, for distribution to all Divisional Forest Officers, and Range Officers, P. W. D. Engineers, Engineering Colleges, District Engineers, District Officers and selected private firms. District Magistrates, and Engineers are being requested either to display them in their offices in prominent places or to send them

to some one in their jurisdictions, who may find uses for them. In this way it is hoped to disseminate widely throughout the Province, knowledge on the proper treatment of timber which the Institute has discovered for us. Only in ways such as this, and by increasing propaganda, can the full benefits of the Institute become widely known and brought into universal practice. The Patna Exhibition last year, followed this year by the Lucknow Exhibition, has brought the Institute into direct contact with wood users. As long as the Institute through local utilisation officers supports such exhibitions, one need never fear that they will lose contact with the needs of the people.

*Enamelled signboards advertising.*—Bihar forest products were exhibited in the following East Indian Railway stations:—

Howrah, Burdwan, Raneegunge and Jheria.

### *Summary of Results.*

In pursuance of the utilisation policy, the Utilisation Officer surveyed markets and established contact between the forest purchasers and markets with the following results:—

*Buxar Jail.*—In the previous year a consignment of sal sleepers and scantlings passed through the Utilisation branch to the Buxar Jail. The consignment was found unsatisfactory and much of it was rejected by the Jail. Absence of precise grading rules was responsible. This unfortunate experience gave the necessary stimulus for collecting and editing more efficient rules which will be used henceforward whenever necessity arises. In the year under review, another consignment was bought by the Jail. The consignment was passed according to the new rules and the Jail expressed satisfaction.

*Tatas market.*—The Utilisation Officer visited the different industrial firms in Tatanagar. The visit to the Tata Iron and Steel firm enabled him to make a survey of its timber requirements. The firm regularly buys teak, *bonsum*, *champ*, padauk, sal, a little *bija* and *semul*. *Bonsum* and *champ* are used in large quantities for making patterns. Teak, padauk, and *bija* are used for furniture. Sal is used as railway sleepers and as shoring boards. *Semul* is used for centering oven arches.

Teak and padauk cannot be replaced altogether by any furniture wood of Bihar, as the size of squares wanted is not found in sufficient quantity. Sal supplies are obtained from this province. The annual requirement of *semul* is 100 tons, the whole of which order was secured. A trial order was also placed for a wagon load

each of *chilbil* (*Holoptelea integrifolia*) and *gumhar* from the Palamau division, to be used for pattern making. These two woods have qualities similar to that of *bonsum* and *champ*; they are light, even grained, easily workable, and less responsive to seasonal swellage and shrinkage. If in practice these woods are found suitable, sustained supplies can be arranged from Palamau division to satisfy the requirements of this firm.

Grouped around Tatas, several subsidiary industries dependant on them for iron and steel have sprung up. The Indian Wire Products, Ltd., consume large quantities of *salai* for making small kegs, and these have hitherto been obtained from Zamindari forests of Palamau. With the inevitable decrease in supplies from these sources, Government forests will be called upon to make up this deficiency. The Indian Cable Company uses 200 tons of Andaman *dhup* annually for Cable drums. *Semul*, *chatni* (*Alstonia scholaris*) and *Albizzia stipulata* could be used as substitutes, but supplies are inadequate. *Salai* from Palamau has been tried but is too heavy.

The Agrico Company buys *geon* (*Excæcaria agallocha*) from Bengal. *Semul* could be used as a substitute for this wood also.

**Boxwoods.**—Several enquiries for boxwoods were also received from Calcutta. It is evident that as India becomes more industrialised, the demand for boxwoods is bound to increase. Without wishing to encroach too much on the Calcutta market, this natural outlet for Bengal, Assam, Burma and Andaman supplies, we should at least attempt to satisfy the needs of our own Province. Kolhan division is favourably situated for supplying in this respect and the Samta Valley in Saranda.

**Planing and planking woods.**—These woods include *gumhar*, *chilbil*, *bhurkund* (*Hymenodictyon excelsum*), *kadam* and *champ*. One market has already been indicated at Tatas. Other enquiries from Calcutta show that there is considerable scope for *gumhar* for light furniture. One man wanted 4,000 tons annually in order to make cheap sandals for export to Japan to compete with those imported now from China. I reluctantly recommended *bonsum* from Assam as we could not supply. Plantations could usefully be made in Kolhan and Palamau for supplying the demand.

**Teak.**—This wood is always in demand for furniture and constructional work and it is advisable to create plantations to supply part of it. Palamau is favourably situated for supplying the Gangetic Plain and the United Provinces where apparently teak is cut back by frost. Saranda and Porahat might add their quotas.

*Plantation aim.*—A modest aim would be to supply 1,000 tons each annually, of boxwoods, planking woods and teak. Reckoning one ton sawn to be equivalent to  $1\frac{1}{2}$  trees of 6' girth, and fifty trees to the acre—30 acres of plantation of each class might be created each year.

*Hardwoods.*—Attempts were made to introduce *asan*, *karam* (*Adina cordifolia*), *bija*, and *siris* from Singbhum into the Bareilly market, but the freight proved prohibitive except in the case of *karam* for which a market might be found.

An order for  $\frac{1}{2}$  ton of *asan* planks of 6"—11" and 11" and over was received. Despite our best endeavours enough planks could not be collected to specification. The trees though big enough, over 7' girth in the marking lists, were hollow or forked, legacies from former heavy fellings, so that few planks wider than 11" could be obtained. Delay occurred in signing the lease and conversion by the contractor did not take place until February, though permission for advance fellings was given. Degrade in seasoning in consequence set in, resulting in excessive splitting especially in the thicker planks of over 1" thickness.

The open gable end of the seasoning shed was a contributing factor as the hot winds of March and April beat down upon the stacks below. In future, felling must take place in the rains, and conversion then or early cold weather, if success is to be expected.

A plywood merchant of Calcutta enquired for a sample of wood named "*pepro*". It was identified as *Gardenia latifolia*, which was not available in the size wanted. *Chilbil* as a substitute was suggested. The enquiry resulted in an order for *chilbil* to the Divisional Forest Officer, Palamau division.

Another firm from Calcutta enquired for "*pepro*". A sample of *Mitragyna parvifolia* was sent as a substitute. No reply has been received.

Messrs. Mullik & Co., of Patna, at their request, were supplied with a piece of *siris* square for the manufacture of gunstocks. Results are awaited.

*Brushbacks.*—Samples of the following species were sent to Messrs. The Brushware Ltd., Cawnpore, for testing for manufacture of brushbacks:—

1. Ebony (*Diospyros melanoxylon*).
2. Satin wood (*Chloroxylon swietenia*).
3. Sissoo (*Dalbergia latifolia*).

4. *Bhurkund* (*Hymenodictyon excelsum*).
5. *Chilbil* (*Holoptelea integrifolia*).
6. *Siris* (*Albizzia procera*).
7. *Gumhar* (*Gmelina arborea*).
8. *Kaka* (*Bridelia retusa*).

Ebony, satinwood and sissoo were pronounced to be suitable for high class (toilet) brushes; *bhurkund* and *chilbil* suitable for kit brushes, and the others for miscellaneous brushes. Sample brushes have been added to our Economic Collection. Although Indian manufacturers pay a good price, their consumption appears to be small.

Enumerations of hardwood species made in Saranda and Kolhan the previous year has enabled us to work out a scheme for supplying these annually and a contractor has been offered a three year lease monopoly. *Asan* finds a ready market, so also does *bija*. *Karam* and *Mitragyna*, mango and *jamun* are not so well known, but by concentrating sales through one man it is hoped to get the sales of these and lesser important species worked up.

#### *Uses of lesser known timber.*

*Palamau division*.—Messrs. F. N. Gooptu & Co.'s report on timber sent to them in September 1935 was received during this year. These were tested for suitability for the manufacture of pen-holders and pencils. The report is as below:—

*Chilbil* }  
*Salai* } are porous and coarse grained and not suitable.

*Bhurkund*.—Rather suitable for pen-holders and very cheap quality pencils but not as good as the two following.

*Wrightia tomentosa*. }  
*Holarrhena antidysenterica*. } Very close grained, moderately soft and work up to a fine smooth surface and as such are most suitable for pen-holders. For pencils they are hard and the white colour is a drawback for use in superior qualities. They can, however, be used for cheap qualities with a good result.

*Foreign Market*.—An attempt was made to create a market for Singhbhum *asan* (Indian laurel) and Palamau satinwood in England, and for satinwood in Japan. There was no immediate demand in the English market, whereas Japan placed their order with Madras.

*Tool handles*.—Our efforts to secure a contractor for making tool handles of *dhaura*, *kusum*, *dhaman*, *kendu*, *asan* and *sidha* have

advanced a stage nearer to success. A man of Ranchi, well versed in mechanical engineering, is getting keen and promises to set up a plant next cold weather. All the information which could be collected has been placed at his disposal. The recent pamphlet written on *yon* (*Anogeissus acuminata*) by the Burma Utilisation Officer is proving of great assistance, and the Forest Research Institute have also been very helpful. Emphasis is laid on the necessity for efficient seasoning prior to fashioning.

*Palamau division.*—A report was received from the Chief Mechanical Engineer, Bengal Nagpur Railway Workshop at Kharagpur, about the suitability of various timbers of which tool handles were sent for testing. It is given below:—

Name of species.	No. of handles tested.	Remarks.
<i>Kusum (Schleichera trijuga).</i>		
Sledge hammer shafts . . .	2	Put in service on 14th October 1935. One still in service in September 1936. Found satisfactory.
Hand hammer shafts . . .	2	Ditto.
File handles . . . . .	2	Suitable for shop use but requires to be a little smaller and fitted with ferrules.
<i>Dhaman (Grewia tiliaefolia).</i>		
Sledge hammer shafts . . .	2	Put in service on 14th October 1935 still in service in September 1936 and found satisfactory.
Hand hammer shafts . . .	2	Ditto.
File handles . . . . .	2	Same remarks as under <i>kusum</i> .
<i>Dhaura (Anogeissus latifolia).</i>		
Sledge hammer shafts . . .	2	No good.
Hand hammer shafts . . .	2	Better than our present issue; should be given a further test.
File handles . . . . .	2	Same remark as under <i>kusum</i> .
<i>Bharul (Chloroxylon swietenia).</i>		
Sledge hammer shafts . . .	2	One tried in smithing work and broke in 2 hours time and the other is still in service good.
Hand hammer shafts . . .	2	One tried in levelling tube ends and broke in half an hour time and the other tried is caulking from 23rd January 1936 to 26th February 1936.
File handle . . . . .	2	Good. Quite suitable for shop use but must be fitted with ferrules.
Size of sledge hammer shafts . . . . .		3 ft. $\times$ 1½ inch $\times$ 1½ inch.
Size of hand hammer shafts . . . . .		1 ft. 6" $\times$ 1½ in. $\times$ 1 in.
File handles 1 . . . . .		5 inches long.

The report on *dhaura* and *bharul* is rather surprising and may be due to timber not being seasoned properly. An enquiry was made if there were any knots in the shafts supplied and it was reported there were no knots in any of the shafts. Later it was reported that the *kusum* sledge hammer shafts were still in service in December 1936.

Pieces of following timbers were sent to Dehra Dun for making up as tool handles for museum specimens:—

- (a) *Kendu* (*Diospyros melanoxylon*).
- (b) *Sidha* (*Lagerstræmia parviflora*).
- (c) *Dhaura* (*Anogeissus latifolia*).
- (d) *Kusum* (*Schleichera trijuga*).
- (e) *Asan* (*Terminalia tomentosa*).
- (f) *Dhaman* (*Grewia tiliæfolia*).

**Poles.**—Owing to the high price of copper wire this year, the Telegraph Department contracts were upset, and the Darbhanga-Laheriasarai scheme for using Ascu pressure treated sal poles fell through. The Keonjhar State scheme appears also to have fallen through for the same reason.

The price of steel which has risen 50 per cent. in last six months has stimulated the demand for Ascu electrical transmission and service lighting wooden poles. Several enquiries have been made. Had treated stocks been available the whole of the Darbhanga order for 350 poles could have been secured. A part of the Ranchi extension order has also been lost for the same reason though there are prospects of securing the remainder of it. Orders towards the close of the year were placed for collecting 600 poles for keeping in stock against anticipated orders.

### (1) *Wood technology.*

Nil.

### (2) *Timber seasoning.*

With the object of demonstrating the method of air seasoning, a seasoning shed has been constructed for Rs. 600 at Chhipadohar in Palamau division where forest purchasers can season planks and boards at a nominal charge.

(3) *Timber testing.*

Nil.

(4) *Wood preservation.*

Messrs. Callender's Ascu preservative plant was transferred from Kodarma to Chippadohar, in anticipation of securing the Telegraph order. It has lately been sent to Singhbhum for electrical pole treatment.

(5) *Minor Forest Produce.*

*Match woods.*—Although enquiries were received, negative replies had to be given as our soft wood resources were inadequate.

*Paper pulp.*—Palamau bamboo forests are being partly utilized for paper pulp. A paper mill is reported to be in erection at Dehri-on-Sone. This will lead to more utilization of the bamboo of Palamau division.

(6) *Paper pulp.*

Nil.

(7) *Tans.*

Nil.

(8) *Grasses.*

An enquiry was received from England for supplying samples of grass mats. Samples of *sabai* mats have since been sent and if approved good business should result.

*Fodder grass.*—With the object of ascertaining the distribution and quality of fodder grasses, a large number of grass specimens have been collected and identified. Those growing extensively will be tested for food value and palatability.

(9) *Hay.*

*Palamau division.*—The export of hay from the division has developed considerably of recent years, through the enterprise of the lessee. *Andropogon contortus* is exported as the standard hay. The spear is removed by knocking it off as each handful is cut. "Blue" grass (not identified) makes the best quality hay. A coarse grass with thick stalk growing along the *nala* banks makes another good hay. Standard hay was sent to the Agricultural

Chemist at Sahour for analysis the result of which is given below :—

Local composition. Percentage on dry matter.	Digestible constituents. Percentage on dry matter.
7.66 Moisture % (in air dry sample).	0.98 Ether extract %.
1.42 Nitrogen %.	4.43 Protein %.
2.0 Ether extract %.	12.61 Fibre %.
8.9 Crude protein %.	30.45 Nitrogen free extracts including carbohydrates.
22.9 Crude fibre %.	35.2 Starch equivalent per 100 lbs.
51.6 Nitrogen free extracts including carbohydrates.	
14.63 Ash %.	

Chemical analysis shows that the grass has good value for stock. Samples of various other grasses were also sent for analysis and a small quality of each to Dehra Dun for identification but no reports have been received so far.

#### (10) *Wood working.*

Nil.

#### (11) *Miscellaneous.*

*Floating.*—For some time past, the Forest Department has been endeavouring to develop the floating of forest produce down the larger rivers of Bihar. Unfortunately most of them are interrupted in their courses by fields of rocks forming dangerous rapids, which render them un-navigable. The cost of improving the floating facilities by blasting out such rocks has till recently been considered prohibitive. The north Koel, for example, which drains Palaman division running northwards into the Sone, and later into the Ganges near Patna, is very favourably situated for development, but an original estimate of two lakhs, coming at the time of the world depression was an effective bar to progress.

Experiments this year have shown that the full width of the river need not be cleared. A channel 20' wide and three quarters of a mile long has been driven at Kechki through the lowest of several fields of rocks in this river, at a cost of only Rs. 530, and it is now expected that the whole river can be made floatable for less than Rs. 10,000. A trial snake-like raft of bamboo hundles tied nose to tail recently successfully negotiated the newly prepared channel.

With the completion of the project the people of Patna and of the thickly populated Gangetic Plain in the neighbourhood will be enabled to purchase, at a much reduced cost, poles and bamboos.

The raw materials for building comfortable homes in which to live, and to use firewood instead of cowdung for cooking. After food and clothing, nothing is more essential to their happiness. New paper mills using bamboos as raw materials will also greatly benefit, while the Department itself can look forward to increased revenues from hitherto comparatively inaccessible areas.

A contractor in Porahat encouraged by our departmental efforts at floating bamboos in the Southern Koel last year has this year rafted 25,000 bamboos to his own and to our advantage.

*Miscellaneous.*—Mr. S. Kamesam, the Timber Development Officer of the Forest Research Institute, paid a hurried visit to Ranchi and interviewed the Superintending Engineer at Ranchi with the writer in order to work out schemes for a more rational and extensive use of Indian timbers.

*Utilisation Conference at Dehra Dun.*—A Utilisation conference was held in March at Dehra Dun, and was attended by delegates from nearly all of the Provinces in India including this Province and also some of the more important States. It is the first conference held for at least fifteen years and signalises a bolder Utilisation policy throughout India. Every Province agreed to make Utilisation the special responsibility of one of its officers. A special Timber Development Branch was opened at Dehra Dun from April 1st, which will be responsible for producing designs, plans and estimates for bridges and buildings of treated timber. These, especially those for bridges should be very useful to engineers. We can scarcely expect them to use structures of timber unless we make it easy for them to do so.

Bengal brought forward a proposal, which had been suggested by this Province eighteen months previously in the Institute's Triennial Report, namely that a Utilisation Branch and showrooms for the Provinces interested, should be opened in Calcutta. This proposal was carried unanimously in committee by the representatives of Bengal, Bihar and Assam and was accepted by the Conference. The Andamans will probably also co-operate. Details are now being worked out for submission to the Governments of the Provinces concerned, and to the Forest Research Institute.

## BURMA.

### I.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Economist was held by Mr. M. N. Gallant, Deputy Conservator of Forests, from 1st April to 15th May 1936, when he was relieved by Mr. H. A. Maxwell, Assistant

Conservator of Forests, who held charge of the post till 10th November 1936 and by Mr. Gallant for the rest of the year under report.

## II.—EXPERIMENTAL ACTIVITIES.

(i) *Summary of the chief activities of the year under report.*

2. The chief activities of the year are summarised below, the details being given later in the sub-sections concerned:—

(a) Arranging for supply and passing of:—

5,000 B. G. *pyinkado* (*Xylia dolabriformis*) sleepers for the Karachi Port Trust through the North Western Railway.

73,000 B. G. *pyinkado* sleepers (3 years contract of which 47,000 supplied during the year) for the North Western Railway.

8,000 special-size *pyinkado* sleepers for the North Western Railway, Karachi.

(b) Passing 1,920 tons of Indian 1st class quality teak squares according to the *Seaman-Limaye Rules for the Grading of Teak squares* for the North Western Railway.

(c) Arranging for the supply of samples of cross-arms for telegraph poles of *pyinkado*, *padauk* (*Pterocarpus macrocarpus*) and *in-kanyin* (*Dipterocarpus* spp.) for the Post Office Stores Department, London.

(d) Conducting experiments in conjunction with Princes Risborough on the variation of moisture content of *in-kanyin* and teak strips during transit to England.

(e) Arranging for supply of teak samples to Princes Risborough from various forests to study their comparative qualities.

(f) Arranging for supply of samples of teak, *taukkyan* (*Terminalia tomentosa*), *in-kanyin*, *padauk* and *pyinkado* to Princes Risborough for natural durability and fire-proofing tests.

(g) Conducting tests on the efficacy of different preservatives against white ant attack on timber both at Rangoon and Pyinmana.

(h) Conducting further experiments on end-coating teak logs at Kyetpyugan Dépôt, Insein division, with various end-coating mixtures.

- (i) Arranging for supply of teak samples of varying rates of growth from different forest areas for strength tests at Dehra Dun.
- (j) Arranging for supply to the Burma Railways a sample consignment of *kanazo* (*Heritiera fomes*) sleepers from the Delta division for trial.
- (k) Working up further data in connection with future royalty proposals.
- (l) Revision of the *Standard for Jungle Rejection of Teak logs*.
- (m) Preparation of notes on a tour through India to study the timber market.
- (n) Investigation into the control of matchwood supplies and revision of royalty rates.
- (o) Answering miscellaneous enquiries on Burma timbers, lac, cutch, paper pulp, hamhoos and other minor forest produce.

3. During the year under report about 3 months were spent on tour—two months in India to study the timber market and one month on sleepers passing, collection of logs, etc.

4. The only new publication of the year was Economic Series Pamphlet No. 9, "*Note on yon as a hammer handle wood*", a concise summary of the properties of *yon*, its availability, milling, seasoning, costs, prices, etc.

In addition, a print of the tentative rules of the *Standard for Jungle Rejection of Teak logs* was circulated to Forest Officers and firms interested.

## (ii) *Details of activities.*

### (1) Wood technology.

5. As in previous years there were no additions to the standard collection of timber specimens authenticated by botanical specimens due to the post of the Forest Botanist being held in abeyance.

6. Hand samples,  $6'' \times 3'' \times \frac{1}{2}''$  of the more important economic timbers were supplied to many enquirers in Burma, India, the United Kingdom and elsewhere.

7. Routine identifications of timbers were carried out for numerous enquirers. The more common timbers were identified by hand lens examination in Rangoon. Microscopic examination was carried out at Dehra Dun, to whom acknowledgments are due for help given.

Timbers for which identification was called for during the year include the following:—

*Nabe*—*Lannea grandis*.

*Thitpwe*—*Elæocarpus* sp.

*Thitni*—*Amoora rohituka*.

*Lelun*—*Sapium* sp.

*Chinyok*—*Garuga pinnata*.

*Didu*—*Bombax insigne*.

*Teak*—*Tectona grandis*.

*Taukkyan*—*Terminalia tomentosa*.

*Pyinkado*—*Xylia dolabriiformis*.

*Bambwe*—*Careya arborea*.

*In-kanyin*—*Dipterocarpus* spp.

8. Two pieces of *kanyin* (*Dipterocarpus* spp.) were sent to the Conservator of Forests Research, Forest Research Instituts, Kepong, Selangor, F. M. S., for marine horer tests.

9. During the year under report 107 pieces of teak from different forests were sent to Dehra Dun to study the strength of teak of different rates of growth.

10. Samples of teak from different localities in Burma were sent to Princes Rishorough to study their qualities for dealing with enquiries as to the variation in the quality of teak appearing on the British market. The report on these samples was received during the year under report and circulated to the teak lessees who contributed the samples.

## (2) Timber seasoning.

11. All kilns gave satisfactory service throughout the year. The three large fan kilns dealt with 31 runs cubing 11,717·8 c.ft. as against 31 runs cubing 11,781·3 c.ft. in 1935-36. Twenty-eight of these runs were of *yon* (10,763·8 c.ft.), 2 of *yinma* (*Chukrasia tabularis*) (652·0 c.ft.) and 1 of *tauikkyan* (*Terminalia tomentosa*) (302·0 c.ft.).

12. The 75 c.ft. fan kiln did 12 runs cubing 826·1 c.ft. as against 12 runs cubing 870·2 c.ft. last year. The runs included 4 of *kanyin*, 1 of *pyinkado*, 2 of *binga* (*Mitragyna diversifolia*), 4 of *hnaw* (*Adina cordifolia*) and 1 of *padauk* (*Pterocarpus macrocarpus*).

13. The 5 c.ft. model kiln was used for experiments on the efficacy of a number of compounds for end-coating timber during kiln-seasoning.

14. Actual running expenses, exclusive of depreciation, were Rs. 17,184-6-9 as against Rs. 17,219-10-6 for 1935-36. The total expenditure of the section inclusive of depreciation charges was Rs. 20,910-14-9, of which Rs. 15,390-14-9 is directly chargeable to the cost of producing 12,543.9 c.ft. of seasoned timber at the rate of Re. 1-3-8 per c.ft., as against Re. 1-3-4 last year. The figure is satisfactory when it is borne in mind that almost all the timber dealt with was  $2\frac{1}{2}$ " thick. It is estimated that for 1" boards, the seasoning charges can be reduced to as low as 6 annas per c.ft.

15. Notes on some of the runs are given below:—

*Taukkyan (Terminalia tomentosa)*.—The charge consisted of  $1\frac{1}{4}$ " boards in varying widths to 16". The moisture content was reduced from 38.0 per cent. to 11.5 per cent. in 21 days with no appreciable degrade. The new process recommended, of frequent steaming treatments, was employed.

*Kanyin (Dipterocarpus spp.)*.—Four runs on  $1\frac{1}{4}$ " flooring strips were made. Results indicate difficulty with timber green from the saw, but the drying of partly air-dried stock is easier, quicker and produces better material. A severe schedule was found to be better than a mild one, but the temperature should not be raised too high. Humidity should be kept low.

It would seem that timbers containing oleo-resins, such as *in* and *kanyin*, should be air-seasoned for six weeks prior to kilning.

*Pyinkado (Xylia dolabriformis)*.—The charge consisted of  $3\frac{1}{2}$ " planks specially cut for telegraph arms for shipment to England. Owing to the thickness of the timber, a mild schedule was maintained. It took 70 days to dry from 50 to 20 per cent. It would appear preferable to air-dry thick material of this sort down to 30 per cent. prior to kilning.

*Padauk (Pterocarpus macrocarpus)*.—The load was of  $1\frac{1}{4}$ " boards of widths varying to 17". It took 19 days to dry from 22 to 10 per cent., with very little degrade.

16. A special study of various methods of kiln operation was started during the year. A  $2\frac{1}{2}$ " run of *yon* was subjected to the method of day heating and over-night cooling. Preliminary results indicate that drying by this method is slower with material of this thickness than is the case with the method involving

continuous heating, though there may be a saving in power and steam. Further investigation is being made.

Other methods of kiln operation to be tried out include Oscillating treatments of temperature and humidities at fixed intervals and periodic reversal of air circulation.

17. *Air seasoning*.—The recording of data on several *yon* stacks carried over from last year was continued until they were either taken over by the workshop or sent to the kilns to finish off the seasoning. Eighteen further stacks of the same species were erected and placed under observation during the year. Of these seven were later unstacked and the seasoning completed in the large kilns, as an urgent call for the timber was made by the workshop. In addition to *yon*, five other species, *binga* (*Mitragyna diversifolia*), *hnaw* (*Adina cordifolia*), *padauk* (*Pterocarpus macrocarpus*), *taungthayet* (*Swintonia floribunda*), *pyinkado* (*Xylia dolabriformis*) were also handled for general air-seasoning. Two of the species, *taungthayet* and *pyinkado* were taken over by the workshop, while the remaining three species are still under observation.

18. In connection with the storage of all timbers in the storage sheds, sample boards are now placed in each pile and they are weighed and measured from time to time so that the actual drying rate of each pile is on record.

19. The research work on teak has been concluded and the results are being analysed and will be dealt with in a separate report.

Similar work on *kanyin* was commenced during the year.

20. *Ventilation in the air-seasoning sheds*.—Data collected indicate results of some importance that will have to be applied in future when air-seasoning our timbers. A report will be drawn up when time permits.

21. *Seasonal variation of moisture content experiments*.—This experiment has been in progress sufficiently long enough to permit of useful deductions being drawn and was therefore brought to an end with the close of the year. The results are being analysed and will be written up in the form of a bulletin to be published later. The publication will include the results obtained for the companion tests on the moisture recovery of kiln samples.

22. One of the large kilns was prepared for Dr. Kapur's proposed visit to demonstrate his new method of kiln drying. The interior walls of the kiln were painted with a moisture proof paint to prevent loss of heat through the walls.

23. An Electric Moisture Meter was purchased from the Forest Research Institute, Dehra Dun. This instrument is designed and constructed at Dehra Dun. A series of tests with Burma woods will be carried out.

24. *Tests on the moisture content changes during shipment.*—A further attempt was made during the year to study the moisture changes in timber during shipment to England. The consignment consisted of *kanyin* flooring, made up into 4 bundles, each bundle having a different moisture content but the pieces in the individual bundles having the same moisture content. From the results recorded by Princes Risborough, it appears that the technique is satisfactory, but the main object of the experiment was defeated by stowing the bundles among other material and not with the same kind of cargo. It is suggested that the experiment be repeated with bundles actually hurried in similar material.

### (3) Timber strength testing.

25. A consignment of 4 logs of *thinwin* (*Millettia pendula*) was sent to the Forest Research Institute, Dehra Dun, during the year for tests under Project VIII—Plywood and Veneers.

### (4) Wood preservation.

26. In view of the failure of last year's experiment on the efficacy of different preservatives against white ant attack an attempt has been made this year to carry out the tests on better lines. Two species of timber have been used, viz., *kanyin* (*Dipterocarpus* spp.) and *taungthayet* (*Swintonia floribunda*) and no less than 11 preservative mixtures. One set of treated samples has been put down at the Government Timber Dépôt in September 1936 and a similar set in the grounds of the Pyinmana Forest School. The soil where the samples are put down was heavily infected with termites and as the samples were arranged to give the maximum amount of infection satisfactory results may be expected from the test. Both in Pyinmana and Rangoon stont fences were erected around the experimental plots.

27. *End-coating tests.*—A re-inspection was made during the year of all end-coated logs and controls in Kyetpyugan Dépôt. Definite results are not likely to be obtained until the logs have come through another hot weather but the conclusions arrived at from this inspection are:—

- (1) *Xylotex*—is by far the most suitable preparation for end-coating logs left in exposed conditions. Very little, if

any change was noted on logs treated with this preparation.

- (2) *Seekay Wax*—is of doubtful value as it appears to flake off when exposed to the weather. It also quickly comes out of deep cracks so that further splitting is not checked. Seekay wax possibly has some effect in preventing fresh splitting.
- (3) *Aluminium paint*—this paint did not appear to have any effect at all as it was all washed off during the rains.
- (4) *Xylotex G. 10 & Seekay Wax (solid)* were also tested out in the kiln. It appears so far that there is little to choose between them. Both compounds stood up effectively to drying temperatures up to 160° F. Above this to 180° F. there was slight blistering and peeling in both cases. Further tests are being carried out.

(5) Minor forest produce.

28. *Lac*.—Samples of dry and wet *gyo* (*Schleichera trijuga*) lac from the Shan States were sent as usual to the Indian Lac Research Institute, Namkum, Bihar, for experimental work.

29. *Cutch*.—Information about supplies of cutch likely to be available during 1936-37 was collected and given to a firm dealing in cutch. A cutch conference was held at Minbu during the year which was attended by a representative of Messrs. Finlay, Fleming & Co., and Mr. A. R. Villar, Conservator of Forests.

30. At the request of Messrs. The Bombay Burmah Trading Corporation, Ltd., a short note on *Tung* oil (*Aleurites fordii*) cultivation in Burma was prepared and forwarded to this firm.

31. Further supplies of the bark and latex of *lettok-gyi* (*Holarrhena antidysenterica*) were sent to the Chemistry Department of the Rangoon University where research is being carried out on this product. An extract of this bark known as "Kurchine" is being used by doctors here in the treatment of dysentery.

32. Further enquiry was received from California regarding *Derris elliptica* root but in view of the fact that the Burma species of *Derris* were not found to have any material insecticidal value there was no object in pursuing the matter further.

33. At the instance of the Silviculturist, Maymyo, 2,000 seeds of *mahogany* (*Swietenia macrophylla*) were collected and sent to the Cantonment Executive Officer, Maymyo.

34. Other enquiries were received for the following:—

Timbers suitable for the manufacture of bobbins and shuttles—  
from India.

Timbers suitable for butter boxes—from Australia.

Substitutes for walnut—from the United Provinces.

Timbers suitable for ladies shoe heels—from Bombay.

Timbers suitable for chopping blocks—from the Rangoon  
Arsenal.

Timbers suitable for manufacture of hockey sticks—from a  
Rangoon firm.

Substitutes for boxwood for spinning rollers—from Ireland.

Burma mulberry logs (*Morus laevigata*)—from London.

Burma timbers for veneers and plywood—from New Zealand.

*Artocarpus hirsuta*—from Lahore.

*Neem* leaves—from a firm in Rangoon.

*Broussonettia papyrifera*—from a firm in Bombay.

Gums suitable for manufacture of chewing gums from  
America.

#### (6) Paper pulp.

35. During the year enquiries were made regarding the possibilities of utilizing *kalan* (*Melaleuca leucadendron*) as a pulp wood. It was, however, found that the tree was not sufficiently abundant to serve as a pulp wood source.

36. Information on the available supplies, method of manufacture, etc., of the paper mulberry bark (*Broussonettia papyrifera*) was furnished to a firm in Bombay who were interested in the manufacture of Shan paper.

37. An enquiry was received during the year regarding the yield of bamboo on different cutting rotations from the sample plots of the Tavoy River area. As the plots were laid down only in 1931, information of this sort is unfortunately not yet available.

#### (7) Tans.

38. Nothing to report under this head. There was an enquiry from a Rangoon firm for mangrove solid extract used by sole leather tanners. Enquiries made from likely Divisions revealed that this commodity is not available anywhere in commercial quantities.

## (8) Wood working.

39. Expenditure and receipts for the Timber Research Branch are given below:—

*Timber Research as a whole.*

Year.	Expenditure.	Receipts.	Difference.
	Rs.	Rs.	Rs.
1935-36 . . . . .	90,762	38,997	—51,765
1936-37 . . . . .	127,376*	40,409	—86,967
Difference . . . . .	+36,614	+1,412	+38,026

*Workshop unit only.*

1935-36 . . . . .	47,259	38,997	—8,262
1936-37 . . . . .	45,960	40,129	—5,831
Difference . . . . .	—1,299	+1,132	+2,431

\* Excludes capital expenditure of Rs. 2,161.

The increase in the expenditure is accounted for largely by the increase in purchase of logs to build up depleted stocks. Otherwise the figures remain stationary, indicating the continued necessity for economy.

40. The Government saw-mill remained closed throughout the year, for reasons of economy, but the machinery was periodically cleaned and greased.

41. Timber supplies were dealt with as in previous years, the logs being cut into fitches in Messrs. Foucars mill and subsequently into boards in the workshop frame-saw.

42. One thousand and forty-eight tons of hardwoods were purchased during the year, of which 864 tons were converted to fitches. The 864 tons produced 708 tons of fitches, with a conversion loss of 18.1 per cent. as compared with 12.8 per cent. last year. These conversion results exclude the recovery of small handle blanks from *pagas* and the supply of fuel to the kilns from unserviceable material. 494 tons of fitches were converted,

producing 440 tons of planks, with a loss of 10.9 per cent., which is considered satisfactory.

43. The proportion of timber used on furniture and on non-furniture work, compared with previous years, is as follows:—

	TONS OF CONVERTED TIMBER CHARGED ON JOB CARDS.			BOOK VALUE OF TIMBER.		
	1934-35.	1935-36.	1936-37.	1934-35.	1935-36.	1936-37.
				Rs.	Rs.	Rs.
Furniture . . . .	15	10	12	3,145	1,919	2,215
Non-furniture . . . .	204	118	208	29,239	15,838	24,879
<b>TOTAL .</b>	<b>219</b>	<b>128</b>	<b>220</b>	<b>32,384</b>	<b>17,757</b>	<b>27,094</b>

Non-furniture woods include hammer and other tool handles, floor blocks, panellings, packing and other timber supplied.

44. Altogether 27 species were handled in the workshop. They are given below in order of descending merit as regards the amount of work done with them:—

Major attention—

Industrial—

- Yon* (*Anogeissus acuminata*).
- Panga* (*Terminalia chebula*).
- Pyinkado* (*Xylia dolabriformis*).
- Ma-u* (*Anthocephalus cadamba*).
- Hnaw* (*Adina cordifolia*).
- Binga* (*Mitragyna diversifolia*).
- Yemane* (*Gmelina arborea*).
- Thitkado* (*Cedrela toona*).
- Taungthayet* (*Swintonia floribunda*).
- Kyilan* (*Shorea assamica*).
- Kyetyo* (*Vitex canescens*).
- Kanyin* (*Dipterocarpus alatus*).
- In* (*Dipterocarpus tuberculatus*).
- Thitmin* (*Podocarpus wallichianus*).
- Didu* (*Bombax insigne*).

## Furniture—

- Yinma* (*Chukrasia tabularis*).  
*Kyana* (*Carapa moluccensis*).  
*Padauk* (*Pterocarpus macrocarpus*).  
*Taukkyan* (*Terminalia tomentosa*).  
*Thinwin* (*Millettia pendula*).  
*Maniawga* (*Carallia lucida*).  
*Sit* (*Albizzia procera*).  
*Sandawa* (*Cordia fragrantissima*).  
*Aukchinza-ni* (*Amoora wallichii*).

## Minor attention—

- Thitka* (*Pentace burmanica*).  
*Thingan* (*Hopea odorata*).  
*Petthan* (*Heterophragma adenophyllum*).

45. *Yon* continues to be in good demand and consumers appear to be satisfied with the standard of handles received. *Bagas* and other waste parts of *yon* not suitable for other purposes were converted into fencing material and tent pegs.

46. *Hnaw* and *binga* continue in favour for mounting blocks. Some *maniawga* was also sold for this purpose. *Panga* was again in demand for sucker rod protectors. Work on *ma-u* and *taungthayet* for boxes and packing cases was continued. Of the ornamental woods, *yinma*, *tauikkyan*, *kyana*, *thitkado* and *sit* were all in demand.

## (9) Miscellaneous.

## 1. Efforts to increase the sale of Burma timbers—

47. In accordance with the policy of the Timber Research Branch, more attention was paid during the year to research on teak, *in-kanyin*, *taungthayet* and *pyinkado*.

48. The present policy of the Branch with regard to the manufacture of *yon* handles is to carry on with the manufacture of about a lakh of handles per annum and at the same time build up stocks of seasoned *yon* plank that will permit manufacture at this rate for the next two years, yet leave sufficient seasoned stock to start off the industry, should it be taken up by private enterprise. Encouraging enquiries were received during the year from two firms in India who are in a position to take up the manufacture of *yon* handles.

49. Efforts are still being made to place teak poles for telegraph posts in the market. An enquiry was received during the year from the Burma Telegraph Department for supply of a small quantity of these poles. The question of supply is being gone into but the quantities required are too small to interest suppliers.

50. Owing to the high cost of the teak sleepers from the Northern Shan States referred to in paragraph 57 of the last year's report it was not possible to induce the Burma Railways to take them over.

51. The total number of *pyinkado* sleepers shipped on behalf of the North Western Railway, Karacbi, during the year under report was 52,000 B. Gs. and 5,000 specials. A further order for 8,000 odd specials and 23,000 B. Gs. will be completed by 31st July 1937. These orders represent an export from Burma of some 6,000 tons of converted timber. The best quality sleepers came from the Pegu Yomas.

52. On behalf of the Eastern Group, Sleeper Pool, Calcutta, tenders for supply of considerable quantities of *pyinkado* sleepers were called for, but none of the offers made by the Burma suppliers were accepted as the prices were too high compared with sal.

53. Samples of cross-arms for telegraph poles according to the Post Office Engineering Department specification were made of *pyinkado*, *in-kanyin* and *padauk* and supplied to the Post Office Stores Department, London. A report on these samples was received after the close of the year stating that the samples were satisfactory and the three timbers concerned have now been added to the Post Office Department's specification.

54. Efforts were made during the year to market floor blocks of various Burma hardwoods, partly with the idea of consuming accumulated off-cuts at the Dépôt. Limited quantities were offered, but should any real demand materialise, it may be possible to interest exporters. Encouraging responses from firms in the United Kingdom, the Continent and India were received. Objections have been raised by the United Kingdom manufacturers to the export of finished blocks and in view of these, efforts will be concentrated on the sale of half wroughts to the United Kingdom for the time being. The sale of floorings is an excellent method of getting our timbers known.

55. A firm in Germany interested in the box-shook trade was supplied with samples of *taungthayet* (*Swintonia floribunda*) sbooks and quotations for round logs c.i.f. Hamburg.

56. A small quantity of seasoned *yemane* (*Gmelina arborea*) was shipped to the Mathematical Instrument Officer, Calcutta, for the manufacture of Mathematical instruments.

57. A request was made by the Director, Imperial Institute, South Kensington, to fill one section of a museum case with Burma hardwood exhibits. Samples of trays, ash-trays, paper cutters, etc., mounted on a board, were supplied.

58. The usual display of Burma timbers was held at the Arts, Crafts and Industrial Exhibition held at Rangoon in February 1937. Arrangements were also made to display Burma hardwood furniture at the Hlegu Rural Uplift Exhibition.

59. The survey of matchwoods of the Province referred to in paragraph 65 of the last year's report was completed during the year. The survey indicates that the supply and demand of matchwoods are about equal.

## 2. Comparative counts of beeholes made by the moth [*Xylutes* (*Duomitus*) *ceramica*] in teak logs from various localities—

60. A conference was held at Rangoon which was attended by Dr. C. F. C. Beeson, Forest Entomologist, Dehra Dun. The beehole borer problem was one of the items of entomological research discussed. Price degrade in teak timber due to beeholing was examined and seemed to justify extended expenditure on control measures of this pest. Dr. Beeson's recommendations on the biological and silvicultural measures of control of the beehole borer were accepted by the conference.

## 3. Departmental export of Burma timbers.

61. Three logs of *taukkyan* (*Terminalia tomentosa*) and 5 logs of *thinwin* (*Millettia pendula*) were exported to England for sale through the High Commissioner for India in London.

62. With the exception of considerable quantities of *yon* handles by the Timber Research Branch to the Indian Railways and round teak logs to the British Admiralty by the Dépôt and Agency Division, no other exports of Burma timbers were made.

## 4. Timber passing—

63. Large quantities of *pyinkado* sleepers to the North Western Railway were passed during the year. The B. G. sleepers from Pegu Yoma forests supplied by Messrs. Bah Oh Teak and Hardwood Co., Ltd., Rangoon, were of excellent quality and the percentage of rejections was very small.

64. An order for supply of 1,920 tons Indian 1st class quality teak squares was placed by the North Western Railway with Messrs. The Bombay Burmah Trading Corporation, Ltd. These squares are being graded by the Forest Economist in accordance with the Seaman-Limaye Rules for the Grading of Teak squares.

Further enquiries for the passing of teak squares for other Indian Railways on the Seaman-Limaye Rules were received.

65. A consignment of teak shingles under shipment to the Public Works Department at Port Blair by Messrs. The Bombay Burma Trading Corporation, Ltd., was inspected and certified during the year.

#### 5. *Wood fuel for the Burma railways—*

66. The scheme for supply of fuel to the Burma Railways continues to work quite satisfactorily. During the year efforts were made to amend the list of wood fuel species which the Burma Railways refuse to accept. About 21 species are excluded from the list of accepted fuel species of which at least 10 provide useful fuel. The Burma Railways approved of the inclusion of these 10 species for lighting up engines and for their Myitnge Workshops but will not accept them for Locomotive use on the Moulmein-Ye line.

#### 6. *Enquiries and liaison—*

67. Miscellaneous enquiries were answered on timber, fuel, bamboos, lac, cutch, tung oil, *Derris elliptica*, etc. The usual liaison was maintained with other specialists in Burma and at the Forest Research Institute, Dehra Dun. Also with the Forest Products Research Laboratory, Princes Risborough, England, Imperial Institute, London, Timber Advisory Officer, Railway and Defence Departments, Delhi, and the Timber Adviser to the High Commissioner for India, London. Acknowledgments are due for help from all these sources.

68. An extended tour of the principal Indian timber markets which included a visit to Dehra Dun was made by the writer on his return from leave during the cold weather. An extensive report on the tour was submitted to Government. The opportunities afforded of consultation with the various experts at Dehra Dun and elsewhere and of enquiry into trade conditions proved of great value.

69. Technical bulletins, journals and other publications were received from Britain, America, Australia, Africa, French-Indo China and the Philippines and elsewhere.

### 7. Ledger filing—

70. Ledger filing was carried out as usual. Matter of interest in the literature received which appeared likely to be important to Burma was ledger filed by extraction or reference.

At the request of the Forest Utilization Officer, Bengal, notes on our system of ledger filing were sent to him.

## CENTRAL PROVINCES.

Mr. Abdus Salam continued to hold charge of the Forest Utilisation Officer's post throughout the year. He attended the Forest Utilization Conference at Dehra Dun in March 1937.

### (i) EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

*Depôt sales.*—The departmental sales of teak timber at Khirkiya, Timarni, Taku, Ellichpur, Akot and Ballarshah depôts were conducted by the Forest Utilization Officer as usual. The total amount of timber handled and the revenue realized at these depôts were:—

	From 1st April 1935 to 31st March 1936.		From 1st April 1936 to 31st March 1937.	
	Quantity.	Amount realized.	Quantity.	Amount realized.
	C.ft.	Rs.	C.ft.	Rs.
Total	810,984	826,604	798,076	744,758

An experiment of collecting and remitting the sale proceeds through a *sahukar*, who was allowed a small commission, proved successful. Rs. 88,588-5 were thus collected and remitted on payment of a commission of Rs. 220-12.

*Lorry transport.*—The Allapilli Timber Transport Company transported from Allapilli to Ballarshah 219,695 c.ft. (258,145 c.ft.) of timber.

*Allapilli Saw Mill.*—Due to the break down of a pulley, the outturn of the mill fell from 85,494 c.ft. to 66,560 c.ft. Sufficient supplies of scantlings of the popular sizes were not always available.

*Scantlings.*—(a) *Teak.*—The total yield of teak scantlings in the Western Circle rose from 18,862 to 23,063 c.ft. which found a ready sale. Hand sawing of small butt ends and top pieces of teak trees was continued in Nimar and intensified in the Bori coupes of the Hoshangabad division. This enabled the coupes to be more fully exploited. Experimental hand sawing tried at Allapilli on a limited scale also proved successful.

(b) *Sal.*—Departmental sawing of scantlings made a further advance to 90,769 c.ft. and the material fetched better prices than last year.

*Sleepers.*—The first year of the three-year contract with the railways has been completed. Incidentally this was also the first year under the quota system. This system proved satisfactory as it afforded an opportunity of maintaining the organization throughout the year which resulted in greater yield of sleepers and scantlings. 40 tenders were submitted, out of which 14 were accepted. Sleeper prices remained stationary. The total value of sleepers supplied during the year amounted to Rs. 2,09,790. Demand for rejected sleepers continued good and all stocks were cleared at a slightly higher price than last year.

*Pit-props.*—Orders for pit-props were secured from Ballarshah and Pench Valley Collieries during the year and complied with. The standard of poles desired for pit-props is high and limits the quantities which can be supplied.

*Gun Carriage Factory, Jubbulpore.*—The Forest Utilization Officer visited the factory twice and obtained an order for 1,000 c.ft. of sal logs and two orders for special size teak planks worth Rs. 1,299.

*Bamboos.*—The departmental bamboo operations were continued in Bilaspur. The revenue realised was Rs. 33,601 (Rs. 11,277).

*Charcoal.*—Demand for charcoal continued to be good and large quantities were manufactured in almost all the divisions situated along the main railway line. Efforts are being made to induce contractors to use the portable "Frikiln" devised at the Forest Research Institute, Dehra Dun.

#### *Various species.*

*Adina cordifolia.*—1,000 c.ft. of rough squared logs were sold on orders from the Ballarshah depôt. Demand for this species continued on a limited scale.

*Terminalia tomentosa.*—775 c.ft. of logs were collected and sold by auction at Khirkiya, where there is a small demand for this timber in the round. Orders for rough squared logs to the extent of 9,500 c.ft. were undertaken and supplied from South Chanda. There is a steadily increasing demand for this timber.

*Ougeinia dalbergioides.*—3,741 c.ft. of logs were collected at Taku depôt and realized the very good price of Re. 1-5 per c.ft. There is a good demand for this timber but unfortunately supplies are very limited.

*Bombax malabaricum*.—Owing to large supplies of light woods from Malabar, the Central Provinces *semal* has received a slight set back and the prices secured during the year were not as good as usual. Messrs. Bhabhraj Jamnala & Co., of Wardha, are putting up a match factory at Chanda, where matches are to be made partly by hand and partly by machines. This is a local enterprise which Government is encouraging by the grant of 253 *semal* trees at a reduced royalty of Rs. 3-13 per tree against Rs. 7-10 obtained in the open market.

*Boswellia serrata*.—The last supply of this timber made to the Eastern Group for making coffins proved satisfactory, and a further order for 10 tons has been received. This species is making headway in the local markets as well. Hand-sawn planks are selling readily in increased quantity as they are proving a good and cheap substitute for teak planks.

*Cleistanthus collinus*.—Two orders for supply of poles were secured and complied with from Ballarshah. Further orders are being negotiated. If supplies can be arranged at reasonable rates, the poles of this species have a good future.

*Gardenia latifolia* and *Gardenia turgida*.—Samples were supplied from North Chanda, Nimar and Hoshangabad divisions to a firm in Navasari and to Messrs. Uberoi & Co., of Sialkot. Both these firms have reported favourably on the samples. The former placed an order for a wagon load which has been supplied from North Chanda. Negotiations to secure an order from the latter firm are in progress.

#### *Minor forest produce.*

*Lac*.—The quantity of lac collected increased in all divisions except Bilaspur, Balaghat and Hoshangabad. The T. N. prices remained practically unchanged except for a short period of two months at the beginning of the year, when a temporary improvement took place. The total amount of lac collected was 89 maunds as against 2,145 maunds in 1935-36.

*Rusa grass*.—Trade in this commodity is still dull and the revenue dropped to Rs. 2,100 (Rs. 3,166).

*Tendu leaves*.—The demand was very brisk and Rs. 63,322 were realised from sales, as against only Rs. 12,158 in the previous year.

*Kulu gum*.—Departmental collection was continued in Damoh and Saugor. Experiments are to be undertaken to ascertain the best method of tapping. Rs. 12,956 (Rs. 14,742) were realised from its sale. The demand was good and prices appreciated

slightly. The decrease in revenue is due to smaller collections. The export to foreign markets from Bombay during the past three years has been:—

Years.	Amount.
1934-35 . . . . .	60,381 cwt.
1935-36 . . . . .	55,485 „
1936-37 . . . . .	72,820 „

*Katha*.—The revenue from leases for manufacturing *katha* was Rs. 12,756 (Rs. 11,095).

*Paper pulp*.—The right to collect *sabai* (*Pollinidium binatum*) grass was leased out in several divisions.

*Harra*.—The prices appreciated and the demand was brisk. Revenue realised from this source amounted to Rs. 6,820 (Rs. 5,760).

## (ii) MISCELLANEOUS.

*Railway freight concessions*.—The question of railway freights for bamboos was taken up with the Bengal Nagpur and the Great Indian Peninsula Railways, and reduced wagon rates were secured for consignments between certain stations on the Bengal Nagpur Railway.

*Poona Exhibition*.—The following exhibits were sent by the department:—

Baskets and mats from Chanda; *haldu* combs and satinwood tea trays from Seoni, solid bamboo walking sticks; wooden dolls and *chhind* mats from Chhindwara; and samples of lac and *kulu* gum from Damoh.

## MADRAS.

The Forest Utilization Officer's functions were revised consequent on the transfer of sales in the Government Timber Depôts to the respective districts, and he has been able to devote more of his time to other important works, namely, study of market conditions, research, and propaganda. He also continued to look after the organization and supply of track and special sized sleepers to the Railways and timber to Government departments and other special markets.

### 1. EXPERIMENTAL SLEEPERS.

These were inspected as usual. The results of the line tests have shown that the average life of untreated B. G. sleepers of *Eugenia gardneri* species is about five to six years.

(2) Test lengths of *Hardwickia binata* B. G. and M. G. sleepers supplied from the Upper Godavari division, and of *Terminalia tomentosa* (karimaradu) B. G. and M. G. sleepers supplied from the Wynaad division have been opened and their first joint inspection will be due in 1937-38.

(3) *Bolted sleepers*.—The result of trial of 1,000 B. G. bolted sleepers laid in the Madras and Southern Mahratta line in 1931-32 are given below:—

Species.	Dates laid.	Nos.	Nos. renewed.	Nos. split at one end.	Percentage.	Nos. split both ends.	Percentage.	Nos. requiring renewal.	Percentage.
<i>Nangal</i>	14th December 1931, 1st September 1932 and 6th April 1932.	612	Nil	113	18.5	117	19.0	32	5.2
<i>Hopea</i>	1st September 1932 and 6th April 1932.	280	Nil	77	27.5	69	24.6	4	1.4
<i>Xylia</i>	1st September 1932 and 10th September 1932.	108	Nil	19	17.6	36	33.3	..	..
		1,000		209		222		36	

The Chief Engineer, Madras and Southern Mahratta Railway, reported that bolting ends of sleepers have not appreciably prevented splitting.

(4) *Eugenia gardneri* sleepers.—13 B. G. creosoted sleepers sent by the Forest Economist, Dehra Dun, and laid in Bezvada district, on inspection by the District Engineer, Madras and Southern Mahratta Railway, in August 1936, showed that one sleeper was badly cracked, eight were badly split at ends, and the remaining four were in good condition.

## 2. WOOD PRESERVATION.

(i) The supply of line poles from Madura district for electric transmission and distribution lines after treatment with Ascu was suggested by the Timber Development Officer, Dehra Dun, during his visit to the Plantations in August 1936.

Messrs. Callenders Cahle and Construction Company, Madras, who are the local agents for Ascu wood preservative have been informed of our rates for the supply of line poles for Ascu treatment, and their move on the matter is awaited.

In the meantime, strength tests of line poles are being arranged to be made at the Engineering College, Madras, and the Forest Research Institute, Dehra Dun.

(ii) Out of six Ascu treated pieces sent from the Forest Research Institute, Dehra Dun, for experiment, 3 were planted at Sultur, about 12 miles from Coimbatore, and the remaining three at Gudalur, 30 miles from Ootacamund in February 1936. When they were taken out in August and October 1936 respectively, they were found to be in good condition.

(iii) *Alder plywood board treated with Ascu*.—A sample piece of alder plywood board received from Messrs. Binny & Co., Madras, was treated with Ascu in the Forest Research Institute, Dehra Dun. The board, brush-coated with Ascu, was found after six months, sound and intact, while the untreated board was completely eaten up by white ants.

(iv) *Osmosis wood preservative*.—Messrs. Massey Ganz, Hackethal (India), Ltd., are the local agents for this preservative. They carried out an experiment with this preservative at Kodai-kanal by treating pine and blue gum poles with Osmosis paint with a view to utilize them as electrical posts. Samples of Osmosis treated wood were sent to the Forest Research Institute, Dehra Dun, for "graveyard" tests. The Utilization Officer, Dehra Dun, reported that there was no attack of any kind so far, but the pieces had been under test for only eight months and as this period included five months of cold weather when there is very little termite activity, it was too early to offer an opinion.

(v) *Xylotex G-10*.—This preservative was reported to be suitable to prevent splitting and cracking in timber. Messrs. Massey Ganz, Hackethal, Ltd., who are the local agents, sent samples of this material for test and it was sent to the Pollachi and Wynaad depôts for test. The result of trial with this preservative was not favourably reported on.

(vi) *End-coating tests. Petroleum asphalt mixed with crude oil and bitumen mixture*.—Petroleum asphalt mixed with crude oil was suggested by Mr. Kamesam, the Timber Development Officer, Dehra Dun, for preventing end-splitting of sleepers. The head office of the Burma Shell Company, Delhi, who are the agents, in consultation with Mr. Kamesam standardised a suitable bitumen mixture for this purpose. Experiments with this mixture were carried out in the sleeper depôts, and in one depôt in which an inspection was made, it was found that the mixture appeared to be helpful in preventing and in controlling end-splits, but a definite opinion could not be formed till results of more treated sleepers are known.

(vii) *Seekay wood preservative*.—This is another preservative coming into use to prevent end-splitting of timber. The Imperial

Chemical Industries, Rangoon, who have local agents, have sent samples of this preservative for test. It is being tried in Pollachi Depôt. This is said to be more effective than the molten Seekay wax tried by the Forest Economist, Rangoon.

### 3. STRENGTH TESTS—PALMYRA POLES.

To determine the suitability of palmyra poles for electrical lines, six palmyra posts from the Cuddapah North division were sent to the Forest Research Institute, Dehra Dun, for strength tests. The result of the tests is awaited.

### 4. PAPER PULP.

(1) Investigation into the possibility of utilizing *botha* grass (*Andropogon schoenanthus*) from Cuddapah forests for the manufacture of paper pulp was undertaken at the instance of the Working Plans Officer, Cuddapah. Preliminary tests by the Paper Expert at the Forest Research Institute showed that it was inferior to *sabai* grass, but it was also reported that it was likely it might be utilised, particularly in admixture with bamboo for the production of medium grade papers, provided it was made available to mills at cheap rates. Hence three tons of *botha* grass are being arranged to be despatched to the Forest Research Institute for large scale tests.

*Cochlospermum gossypium* wood.—The suitability of pulp from *Cochlospermum gossypium* for paper manufacture was suggested and the Forest Economist, Dehra Dun, was also interested in having it tested at the Forest Research Institute. He wanted to know before undertaking the test if the wood is available in large quantities and at economic rates in the forests of this Presidency. The Conservators have reported that this wood cannot be exploited in commercial quantities and at economic rates, and finally the question was dropped.

### 5. WOOD INDUSTRIES.

(i) *Aircraft wood*.—Owing to paucity of supplies of *Polyalthia fragrans* of the specification required for aircraft work, the matter had to be dropped.

(ii) *Shuttles*.—A supply of 200 blocks of *Mesua ferrea* from the Palghat division was made to Messrs. Patel & Co., Bombay,

for trials in the manufacture of shuttles, etc. The firm has since reported that they are not snitable.

(iii) *Veneer and plywood*.—Information regarding supplies of Madras woods suitable for a contemplated veneer and plywood factory by a French firm was furnished to the Forest Economist, Dehra Dun, who forwarded the information to the firm.

(iv) *Picking sticks*.—A small quantity of *Grewia tiliaefolia* from the Wynaad division was supplied to the Buckingham and Carnatic Co., Ltd., for use in the manufacture of picking-sticks.

## 6. COMMERCIAL ACTIVITIES.

(i) *Track sleepers*.—29,776 B. G. and 16,503 M. G. hardwood sleepers were supplied during the year to the South Indian Railway at Rs. 6 per B. G. and Rs. 2-12 per M. G. affording a total revenue of Rs. 2,24,039-4 to the Department.

(ii) *Teak special-size sleepers*.—23,511 teak special-size sleepers were supplied to the South Indian Railway during the year, valued at Rs. 2,47,271.

(iii) *Timber supply—Public Departments*.—The requirements of the Public Works Department and other timber consuming departments were mostly for sawn timber; the Electricity department, Mettur Dam, bought logs—809 c.ft. of teak and 467 c.ft. of *pillamaradu* were supplied to them. A small quantity of about 88 c.ft. of teak was also supplied to the Central Jail, Salem.

The marketing of sandalwood in foreign countries was investigated and some of the firms in England and America were informed of the oil contents of trunk and root classes, which were equal to Mysore sandalwood oil recognised in British and American pharmacopœia. A firm in the United States of America and another in France evinced great interest in the information supplied and they were put in touch with our usual hulk purchasers in Bombay.

(iv) *Timber Market*.—The year opened quietly but soon afterwards prospects of a good business in rosewood were noticed and taken full advantage of. The railway tender for a large supply of indigenous teak gave the much desired upward trend to prices at the close of the year.

The rate for good quality teak and rosewood logs ranged from Re. 1-8 to Rs. 2-12 per c.ft. Oversea quality rosewood logs (72"

and up in girth) realised Rs. 5 to Rs. 13 per c.ft. and a few of the rosewood logs fetched peak prices from Rs. 23 to Rs. 28 per c.ft. The demand for rosewood logs continued during the year. Other miscellaneous hardwood logs ranged from Re. 0-12 to Re. 1-8 per c.ft.

Apparently Japanese demand for red sanders wood declined during the year for the rates realised in the auctions in Cuddapah and Chittoor divisions were poor. From the exceptionally high prices of Rs. 10 to Rs. 27 per c.ft. fetched in the previous year, the highest rate obtained did not go more than Rs. 3-15 per c.ft. This is nothing unusual as with high prices consumers look round for substitutes. If a good substitute is found, the price of the original article has of necessity to come down, if it is to be marketed. Boom prices are poor foundations for calculations of future profits.

During the year it was also noticed that there was a foreign demand for root-wood of red sanders for its excellent dyeing properties.

(v) *Exhibition*.—The Utilization division participated in the annual Park Fair Exhibition held in December 1936. Our stalls attracted many visitors and many enquiries were received.

Samples of figured Gadavari teak, Wynaad laurel, red sanders (wavy grain) wood, lac and lac products, and a few important minor forest products were sent to the Poona Industrial Exhibition, Lord Reay Industrial Museum, Poona.

8. The Forest Utilization Officer attended the Utilization Conference held in March 1937 in Dehra Dun, and took the opportunity of acquainting himself with the latest developments in the various sections of the Utilization branch in the Forest Research Institute.

### *Minor Forest Products.*

*Nux vomica*.—The demand for *Nux vomica* was mainly for export overseas. About 365 candies of Sriharikota stock collected departmentally were sold at Rs. 11-4 per candy as against Rs. 12-8 per candy realised in the previous year.

*Tans*.—The demand for indigenous tan barks of *Cassia auriculata* and *Cassia fistula* was reported to be below normal during the year excepting the last quarter when a slight increase was noticed on account of restricted import of wattle bark.

Prices too continued to rule low till February 1937. For comparison, the prices of local and imported tan barks in the Madras market are detailed below:—

Month.	Price per ton of <i>Cassia</i> <i>auriculata</i> .	Price per ton of <i>Cassia</i> <i>fistula</i> .	Price per ton wattle bark.
	Rs.	Rs.	Rs.
April 1936 . . . . .	68 to 90	41 to 45	87 8 0
May 1936 . . . . .	72 to 95	50	87 8 0
June 1936 . . . . .	72 to 107	50 to 54	85 8 0
July 1936 . . . . .	77 to 109	45 to 54	90 0 0
August 1936 . . . . .	77 to 102	50 to 54	92 8 0
September 1936 . . . . .	68 to 100	50 to 54	92 8 0
October 1936 . . . . .	77 to 101	45 to 50	95 0 0
November 1936 . . . . .	64 to 98	32 to 47	95 0 0
December 1936 . . . . .	64 to 93	41 to 50	97 0 0
January 1937 . . . . .	68 to 95	52	99 8 0
February 1937 . . . . .	82 to 124	68	115 0 0
March 1937 . . . . .	115 to 132	68 to 81	125 to 150

*Tan bark—marketing of.*—An investigation into the suitable sizes and weights of packages for marketing the indigenous tan barks as attractively as foreign barks was made in consultation with the Director of Industries and the Superintendent, Leather Trades Institute, Madras. The Superintendent's recommendation to retain the present size of package but to standardize its weight to 250 lbs. was communicated to Conservators for transmission to District Forest Officers and their bark contractors for giving effect to it in due course.

*Wattle bark.*—Wattle bark has been found very useful in tanning hides. As its imports into Madras had considerably increased within the past ten years, the advisability of growing wattle in suitable areas in this Presidency has been examined. Localities reported as suitable for raising it in plantations are the Palnis in Madura District and the Nilgiris. The matter is being pursued.

(ii) *Avaram bark.*—As the annual yield of the local tan barks from Government lands and forests is far below the requirements

of the Madras tanners, Government have ordered the raising of plantations of *avaram* wherever possible and action is being taken thereon in suitable districts.

*Tangedu experimental plots.*—*Avaram* bark from the two year old coppice shoots in all the five experimental plots in Vizagapatam division was sent to the Leather Research Chemist, Madras, for analysis. The analytical result is awaited.

*Lac.*—Cultivation of lac was continued in Cumbum range, Madura District. The yield was disposed of locally in the Presidency as scraped lac (11,450 lbs.), as washed lac (2,987 lbs.), and the revenue realised therefrom was Rs. 2,950-15 as against Rs. 6,692 realised in the previous year. The fall in revenue is due to poor yield and to lower market rates. Scraped lac was sold at Rs. 16 and Rs. 15 per maund as against Rs. 18 and Rs. 16-8 per maund realised in the previous year; and washed lac at Rs. 25 and Rs. 20 per maund as against Rs. 30 during last year.

The supply of 650 lbs. of seed lac to the Superintendent of Prisons, Madras, was made at the agreed rate of Rs. 21-9 per maund f.o.r. Madras.

The fall in price of lac in the Calcutta market affected our prices also. But so long as the price of the natural lac continues to rule low it will not be easy for the numerous substitutes to oust it from industries where it has been valued for its intrinsic qualities. Its demand in future would remain assured.

A firm on the West Coast has started a wood polish business and purchased about 2,050 lbs. of washed lac from Cumbum range. Should the venture prove remunerative the firm would continue to get its requirements of grain lac from the department.

The lac produced in Salem North division is mainly converted into shellac and wood polish, and supplied to Jails and Borstal schools and to Messrs. Spencer & Co., Madras. The total quantity of wood polish supplied (i) to various Jails, is about 235 gallons, valued at Rs. 890-9; and (ii) to Messrs. Spencer & Co., is 110 gallons costing Rs. 456-8.

Attempts are being made to extend the sales to Public Works Departments, Railways, and the Indian Stores Department, New Delhi.

Test crops on an experimental basis were tried in Mndumalai range in the Nilgiris. Results so far have proved satisfactory.

*Fuel from Cuddapah division.*—In September 1935, the Madras and Southern Mahratta Railway granted a uniform rate of freight for transport of fuel from Cuddapah and Chittoor divisions to

**Madras.** This concession proved advantageous to Cuddapah North division which was farthest from Madras, and resulted in a market increase in export of fuel from that division.

*Dye yielding plants.*—Root and bark specimens of *Morinda citrifolia*, *Ventilago madraspatana* and *Soyimida febrifuga* were supplied to the Government School of Dyeing and Printing, Cawnpore, to enable the Principal to show at the Lucknow Exhibition the dye yielding indigenous plants.

*Divi-Divi for boiler compound.*—From the local tanning materials recommended to the Madras and Southern Mahratta Railway, for the preparation of boiler compound their Chemist, and Metallurgist selected *divi-divi* for trial and asked for a sample, which was arranged from Vizagapatam. Finding it satisfactory, he took over the whole stock at a good rate of Rs. 13-8 per candy, while the local Madras rate was only about Rs. 7 a candy. Their requirements are estimated at about 3 to 4 tons annually.

## ORISSA.

### (v) UTILIZATION.

#### I.—GENERAL WORK AND ADMINISTRATION.

Owing to limited staff no organized utilisation work was done during the year.

#### II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

2. Consignments of laurel wood, consisting of 50 logs in all, were sold to the Timber Adviser to the High Commissioner for India, London.

1st consignment—for 54" and up mid girth at 3s. 9d.

72" and up mid girth at 4s. 9d.

2nd consignment—for 54" and up mid girth at 4s. 0d.

72" and up mid girth at 5s. 0d.

The timber was supplied from the Angul division.

Out of the 25 logs ordered under the first contract two were sent after the close of the year. On their arrival in London the broker informed the Timber Adviser to the High Commissioner for India that one of them was the finest example of figured laurel that he had ever seen, and that if it had been sent on consignment it would have fetched at least 25s. per c.ft.

In Barapahar division, work on improving the Mahanadi Channel for floating purposes was continued. 17,830 bamboos were

floated down the river from Ramedega to Sambalpur ghat at a cost of Rs. 344, or Re. 1-15 per 100. The costs include carting from the forest to Ramedega. Experimental floating in minor rivers such as the Danta and Jira was also undertaken. It is stated that villagers and contractors evinced great interest in the experiments and were keen to start floating on their own next year.

Negotiations have taken place with the newly formed Orient Paper Mill Company for the grant of long term bamboo leases in Sambalpur and Barapahar divisions. The Company has already started work on the erection of their mill at Ib station, Sambalpur district.

A proposal to erect a seasoning kiln at Cuttack is under the consideration of Government. Cuttack is an important carpentry centre with more than a local reputation. The normal consumption of timber by carpentry firms in Cuttack exceeds that of the kiln—400 c.ft. per month—which it has been proposed to erect. If the Capital of Orissa is fixed at Cuttack, or its vicinity, there will be an increased demand for sawn timber. A private contractor has agreed to erect the kiln, provided Government gives a lead by agreeing to purchase seasoned timber required by the Public Works Department from him. It now merely remains to settle the terms on which the Public Works Department will take seasoned timber.

The Public Works Department has been asked to build Ascu treated wooden bridges in place of ferro-concrete structures, whenever the former are possible. It is satisfactory to note that for the next main road projects they have agreed to do so. In their estimates they have provided for wooden culverts and the purchase of an Ascu treatment plant.

### UNITED PROVINCES.

The province is still without a Utilisation Officer, but it is hoped that one will be appointed at the beginning of next working season.

A small experimental unit for Ascu treatment of fence posts, saplings and softwood sleepers was erected in the Haldwani division but was not in operation during the year. Delay occurred owing to the difficulty in obtaining Ascu at a suitable price.

The Hydro Electric Department was supplied with 1,679 sal sapwood *ballis*, 33' and 36' long for use as electric transmission poles after treatment by the Ascu process.

Ten seers of *Pongamia glabra* bark were supplied to the Forest Research Institute to test the tannin contents.

Considerable progress has been made with the propagation of lac in the Jhansi division, 209 maunds of stick lac and 17 maunds of dust lac were sold at a net profit of Rs. 615. A useful start has also been made in Banda division.

An experiment has been started in Jhansi to determine the best method of tapping *Sterculia urens* (*karar*) trees for gum.

A small consignment of *Anogeissus latifolia* timber was sent to the Forest Research Institute to test the suitability of this timber for tool handles.

*The Lucknow Exhibition.*—An Industrial and Agricultural Exhibition was held in Lucknow from December 5, 1936, to February 24, 1937. With the collaboration of the Forest Research Institute the Forest Department put up a very interesting and instructive exhibit in this Exhibition. The Forestry Court was situated in attractive surroundings among trees and flower gardens. About the most important exhibit was the "Ascen Cottage". This was a model double storied wooden house proof against earthquakes, storms, white ants, borers and fungus. It was constructed and erected by the Forest Research Institute. The house was built entirely of Ascen treated *chir* pine timber with the exception of ply wood used for part of the inside panelling and part of the roof. One room was panelled in *sissoo* ply wood and furnished with high class Indian wood furniture, both made at the Forest Research Institute. Another room was furnished with painted furniture made out of cheap Indian wood in modern designs. Other rooms contained various exhibits, such as a Moisture Meter electric instrument and a series of exhibits showing the method of paper manufacture.

There were also lecture and exhibit rooms containing a variety of exhibits lent by various institutions or firms. This room also had a display of nearly 200 hand specimens of different Indian woods.

*The Erosion Model.*—This was a case containing two models, one representing a forest-clad hill-side with a permanent stream and a flourishing village and fields, the second was topographically almost an exact replica of the first but the hill-side was bare with no trees. The object of this model was to demonstrate how necessary the protection and maintenance of forests are for the continued well-being and prosperity of mankind, especially in the hills.

Other features of the Exhibition were the reading and rest room, the *katha* making demonstration, the *Tharu* hut, the wild life

pavilion, an air-seasoning stack, the Forest Research Institute portable charcoal kiln, the Ascu pressure plant erected by Messrs. The Callender's Cable and Construction Co., Ltd., and a laminated bowstring wooden forest bridge.

Some distance away from Forestry Court was a heavy traffic wooden bridge constructed of Ascu treated timber. This bridge was 16' wide and had a clear span of 48', capable of carrying a distributed live load of 35 tons. The Forestry Court was generally acknowledged to be one of the most attractive and instructive courts in the Lucknow Exhibition.

It is believed that as a result of the demonstrations and exhibits put up by the department not only has great stimulus been imparted to the use of timber for many purposes for which other materials are used at present but, what is more important, a large measure of success has been achieved in bringing home to the general public the tremendous value of the forests and the urgent necessity of preserving and improving them.

## APPENDIX I.

*List of Provincial Forest Publications of 1936-37 (excluding the Forest Research Institute Publications).*

## ASSAM.

Flora of Assam by U. N. Kanjilal, P. O. Kanjilal, A. Das and C. S. Purkayastha, Volume I, Part II.

*Indian Forester—*

Three years in Garo hills, by R. N. De.

Simul plantation in Assam.

A short note on Simul plantations in Assam by J. N. Das.

Sal natural regeneration in Assam, by A. J. W. Milroy (with a note by H. G. Champion).

## BENGAL.

Notes on thinning in plantations, by C. K. Homfray. (Bengal Forest Bulletin No. 1.)

*Indian Forester—*

A note on timber extraction in the Chittagong hill tracts, Bengal, by R. I. Macalpine.

## BIHAR.

*Indian Forester—*

Effect of forests on erosion, floods, climate and rainfall and on irrigation experiments. Summary of a lecture delivered by W. D. M. Warren.

The Bihar and Orissa forest staff at the Patna Exhibition, 1936, by W. D. M. Warren.

## BURMA.

Note on *yon* as a bammer handle wood, a concise summary of the properties of *yon*, its availability, milling, seasoning costs, prices, etc. (Economic Series, Pamphlet No. 9.)

Some experiments on the control of bamboo shot hole borer *Dinoderus* spp. in bamboo dunnage, by D. J. Atkinson. (Burma Forest Bulletin No. 32.)

*Indian Forester—*

Fuel camp athletic association, by A. Long.

Prize day at the Burma Forest School, Pyinmana.

A short survey of developments in the use of *yon* for tool handles, by M. N. Gallant.

Shwebo Forest Division, Upper Burma, by F. G. Burgess.

Charcoal burning in the south Pegu forest division, by A. J. S. Butterwick.

## CENTRAL PROVINCES.

*Indian Forester—*

Thinning intensity, by K. P. Sagreiya.

Frost in the Central Provinces, by O. M. Harlow.

## MADRAS.

## Indian Forester—

*Xylia xylocarpa* for sleepers, by E. K. Krishnan (with a note by Forest Economist).

A brass gauge for use in making teak stumps, by A. L. Griffith.

*Dendrocalamus strictus*—Intensive working, by J. A. Wilson.

The beginning of teak plantations in India, by M. V. Laurie.

## ORISSA.

## Indian Forester—

Additional note on plantation of *Dalbergia sissoo* in Keonjhar State, by H. F. Mooney.

Thinnings in coppice crops, by J. W. Nicholson (with a note by H. G. Champion).

## PUNJAB.

Note on some factors which have contributed to the early revision of recent working plans, by A. P. F. Hamilton and N. G. Pring (Punjab Forest Record, Volume I, No. 1).

Effect of forest in preventing floods—Punjab Forestry Notes, No. 1.

## Indian Forester—

The problem of natural regeneration of silver fir (*Abies spectabilis*), by I. D. Mahendru.

The practical problem of the management of the Himalayan fir forests, by H. M. Glover.

The Hoshiarpur Siwaliks from the air, by H. M. Glover.

A forest fire caused by falling stones, by G. R. Henniker-Gotley (with a note by I. G. F.).

Result of blue pine lopping in Balson State, Simla hills, by Pritam Dass (with a note by I. G. F.).

Thinnings in Simla division, by N. G. Pring.

Note on *Lantana camara* in the Simla hills, by N. G. Pring.

Afforestation of the Ridge at Delhi, by R. N. Parker.

Punjab erosion conference, by R. MacLagan Gorrie.

Root suckers of Semal, by L. B. Holland.

Tree lopping on a permanent basis, by R. MacLagan Gorrie.

Note on soil erosion in the Punjab, by R. MacLagan Gorrie.

## UNITED PROVINCES.

Approximate volume table for *haldu* (*Adina cordifolia*) by E. C. Mobbs. (U. P. Forest Leaflet No. 6.)

Resin industry in Kumaon compiled in the Kumaon Circle, by R. G. Marriott. (U. P. Forest Bulletin No. 9.)

U. P. Forest Pocket Book, by S. H. Howard, 4th edition, 1937.

Second Interim Report on the Makhdumpur *Usar* experiment (U. P. Forest Leaflet No. 8), by F. C. Ford Robertson.

Record of seeding of the common tree species in the U. P. (U. P. Forest Leaflet No. 7), by F. C. Ford Robertson.

*Indian Forester—*

Seedling regeneration in B.3 sal, by E. A. Smythies.

A note on regeneration in the Dehra Dun forests, by W. A. Bailey.

Notes on Gonda division, by R. O. Drummond.

Sal natural regeneration experiments in the United Provinces, by E. C. Mobbs.

The Hailey national park, by E. A. Smythies.

Porcupine-proof fencing, by E. C. Mobbs.

Village uplift and its connection with forestry, by K. D. Joshi.

The United Provinces forest department (Canning) benevolent fund.

Note on the results of afforestation of Jumna, Chambal and other ravines.

The Forestry Court—U. P. Agricultural and Industrial Exhibition, Lucknow, by D. Stewart.

## APPENDIX II.

*Statement showing rank, designation and address of Forest Officers employed exclusively on research work in the various Provinces during the year 1936-37.*

Serial No.	Name.	Designation.	Address.
1	Mr. C. S. Purkayastha, Deputy Conservator of Forests.	Held the combined post of Botanical Officer and Silviculturist, Assam, from 1st April 1936 to 1st November 1936.	Shillong.
2	Dr. N. L. Bor, Deputy Conservator of Forests.	Held the combined post of Botanical Officer and Silviculturist, Assam, from 2nd November 1936 to 31st March 1937.	Shillong.
3	Mr. S. M. Deb, Extra Assistant Conservator of Forests.	Forest Utilisation Officer, Assam	Gauhati.
4	Mr. R. I. Macalpine, Deputy Conservator of Forests.	Silviculturist, Bengal, from 1st April 1936 to 31st October 1936.	Darjeeling.
5	Mr. C. K. Homfray, Deputy Conservator of Forests.	Silviculturist, Bengal, from 1st November 1936 to 18th February 1937.	Darjeeling.
6	Mr. S. J. Curtis, Deputy Conservator of Forests.	Silviculturist, Bengal, from 19th February to 17th March 1937.	Darjeeling.
7	Mr. J. C. Nath, Deputy Conservator of Forests.	Silviculturist, Bengal, from 18th March 1937 to 31st March 1937.	Darjeeling.
8	Mr. W. E. Hodge, Deputy Conservator of Forests.	Forest Utilisation Officer, Bengal, from 1st April 1936 to 24th October 1936.	Calcutta.
9	Mr. C. T. Trigg, Deputy Conservator of Forests.	Forest Utilisation Officer, Bengal, from 25th October 1936 to 31st March 1937.	Calcutta.
10	Mr. W. D. M. Warren, Deputy Conservator of Forests.	Forest Research Officer, Bihar	Ranchi.
11	Mr. C. W. D. Kermod	Silviculturist, Burma (throughout the year).	Maymyo.
12	Mr. L. J. Vernal	Forest Entomologist, Burma, (from 1st April 1936 to 9th January 1937).	Maymyo.
13	Mr. B. Unwin	Conservator of Forests, Working Plans Circle, in current charge of the post of Forest Entomologist, Burma, for the period from 10th to 22nd January 1937.	Maymyo.
14	Mr. P. F. Garthwaite	Forest Entomologist, Burma (from 23rd January 1937 to end of year).	Maymyo.
15	Mr. M. N. Gallant	Forest Economist, Burma (from 1st April 1936 to 14th May 1936).	Rangoon.
16	Mr. H. A. Maxwell	Forest Economist, Burma (from 15th May 1936 to 9th November 1936).	Rangoon.
17	Mr. M. N. Gallant	Forest Economist, Burma (from 10th November 1936 to end of year).	Rangoon.
18	Mr. H. C. Watts, Deputy Conservator of Forests.	Silviculturist, Central Provinces, from 1st April 1936 to 14th September 1936.	Nagpur.
19	Mr. H. C. B. Jollye, Deputy Conservator of Forests.	Silviculturist, Central Provinces, from 26th October 1936 to 3rd March 1937.	Nagpur.

Serial No.	Name.	Designation.	Address.
20	Mr. K. P. Sagrelia, Deputy Conservator of Forests.	Silviculturist, Central Provinces, from 4th March 1937 to 31st March 1937.	Nagpur.
21	Mr. Abdus Salam, Extra Assistant Conservator of Forests.	Utilisation Officer, Central Provinces, (throughout the year.)	Nagpur.
22	Mr. A. L. Griffith, Deputy Conservator of Forests.	Silviculturist, Madras . . .	Ootacamund.
23	Mr. M. Srinivasa Raghavan, Extra Assistant Conservator of Forests.	Assistant Silviculturist, Madras .	Ootacamund.
24	Mohamed Abdal Haiz Sahib, Extra Assistant Conservator of Forests.	Forest Utilisation Officer, Madras .	Madras.
25	Mr. J. W. Nicholson, Officiating Conservator of Forests.	Also carried out the duties of Research and Working Plans Officer (throughout the year) in addition to his own.	Angul.
26	Dr. R. M. Gorrie, Deputy Conservator of Forests.	Divisional Forest Officer, Silvicultural Research Division, Punjab.	Lahore.
27	Mr. I. D. Mahendru, Extra Assistant Conservator of Forests.	Attached Officer, Silvicultural Research Division, Punjab.	Lahore.
28	Mr. R. S. Chopra . . . . .	Attached Officer, Silvicultural Research Division, Punjab.	Lahore.
29	Mr. F. C. Ford Robertson, Deputy Conservator of Forests.	Silviculturist, United Provinces, (throughout the year.)	Naini Tal.
30	Mr. Sohan Singh Negi, Extra Assistant Conservator of Forests.	Assistant Silviculturist, United Provinces.	Naini Tal.

## APPENDIX III.

*Publications of the Forest Research Institute, Dehra Dun,  
available for Sale.*

## SILVICULTURE SERIES.

## BULLETINS (Old Series).

Rs. A. P.

- \*4. *Ficus elastica* : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry . . . . . 0 12 0

## PAMPHLETS.

- \*6. Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger . . . . . 1 0 0  
 \*8. Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia . . . . . 0 10 0  
 \*9. Tables showing the Progress in Working Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author . . . . . 0 10 0  
 \*16. Note on the Best Season for Coppice Fellings of Teak (*Tectona grandis*), by R. S. Hole . . . . . 0 4 0

## BULLETINS.

2. Memorandum on Teak Plantations in Burma, by F. A. Leete . . . . . 0 10 0  
 \*8. Note on some Germination Tests with Sal Seed (*Shorea robusta*), by R. S. Troup . . . . . 0 2 0  
 \*22. Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup . . . . . 0 5 0  
 \*30. The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup . . . . . 0 2 0  
 \*33. Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill . . . . . 1 0 0  
 \*41. Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion . . . . . 0 8 0  
 \*45. Note on the Miscellaneous Forests of the Kumaon Bhabar, by E. A. Smythies . . . . . 1 0 0  
 \*46. Rate of Growth of Bengal Sal (*Shorea robusta*), I Quality, by S. H. Howard . . . . . 1 0 0  
 \*47. Volume Tables and Form Factors for Sal (*Shorea robusta*), by the same author . . . . . 0 6 0  
 \*58. General Volume Tables for Chir (*Pinus longifolia*), by S. H. Howard . . . . . 0 8 0  
 \*62. Preliminary Yield Table for *Dalbergia sissoo*, by S. H. Howard . . . . . 0 2 0  
 \*65. Tables for bark deductions from logs, by S. H. Howard . . . . . 0 3 0  
 \*67. Chir (*Pinus longifolia*) Seed Supply, by S. H. Howard . . . . . 0 3 0  
 \*78. The Problem of the Pure Teak Plantation, by H. G. Champion . . . . . 0 12 0  
 \*82. The Measurement of Standing Sample Trees, by H. G. Champion . . . . . 1 2 0  
 \*83. Provisional Yield Table for *Quercus incana* (*Banj* or *Ban oak*), by H. G. Champion and I. D. Mahendru . . . . . 0 14 0  
 \*86. Cold Weather Planting in Northern India, by H. G. Champion . . . . . 0 9 0  
 \*87. Yield Tables for Teak Plantations in Java, by H. G. Champion . . . . . 0 14 0  
 \*88. Seasonal Progress of Height Growth in Trees, by H. G. Champion . . . . . 0 14 0  
 \*89. Effect of Defoliation on the increment of Teak Saplings, by H. G. Champion . . . . . 0 3 0  
 \*91. Damage by Frost at New Forest, Dehra Dun, during 1930 to 1934, by Bachaspati Nautiyal . . . . . 0 12 0

SILVICULTURE SERIES—*contd.*FOREST RECORDS (*Old Series*).

			Rs. A. P.
*Vol.	V, Part	II.—Note on Blue Gum Plantations of the Nilgiris ( <i>Eucalyptus globulus</i> ), by R. S. Troup . . .	1 6 0
*Vol.	VI, Part	II.—Statistics compiled in the Office of the Silviculturist, Forest Research Institute, Dehra Dun, during 1915-16 . . .	1 6 0
*	" Part	V.—Statistics compiled in the Office of the Silviculturist, Forest Research Institute, Dehra Dun, during 1916-17 . . .	0 10 0
*Vol.	VIII, Part	II.—The Regeneration of Sal ( <i>Shorea robusta</i> ) Forests, by R. S. Hole . . .	2 2 0
*	" Part	IV.—Notes on Artificial Regeneration in Bengal, by A. K. Glasson, P. T. Russell, E. O. Shebeare and L. E. S. Teague . . .	2 0 0
*Vol.	IX, Part	VII.—Note on the Possibilities of Camphor Cultivation from <i>Cinnamomum camphora</i> in Northern India, by S. H. Howard, W. A. Robertson and J. L. Simonsen . . .	1 4 0
*Vol.	X, Part	III.—A Sal Yield Table for the United Provinces, by E. A. Smythies and S. H. Howard . . .	1 5 0
*	" Part	VI.—General Volume Tables for Sal ( <i>Shorea robusta</i> ), by S. H. Howard . . .	1 7 0
*Vol.	XI, Part	II.—Contributions towards a knowledge of Twisted Fibre in Trees, by H. G. Champion . . .	2 8 0
*	" Part	III.—Regeneration with the assistance of <i>Taungya</i> in Burma, by H. R. Blanford . . .	1 4 0
*	" Part	VII.—Volume Tables for Teak and Sal for the Central Provinces, by V. K. Maitland . . .	0 9 0
*Vol.	XII, Part	I.—Volume and Outturn Tables for Sal, by S. H. Howard . . .	1 2 0
*	" Part	IV.—Yield Table for clear-felled Sal Coppice, by S. H. Howard . . .	0 8 0
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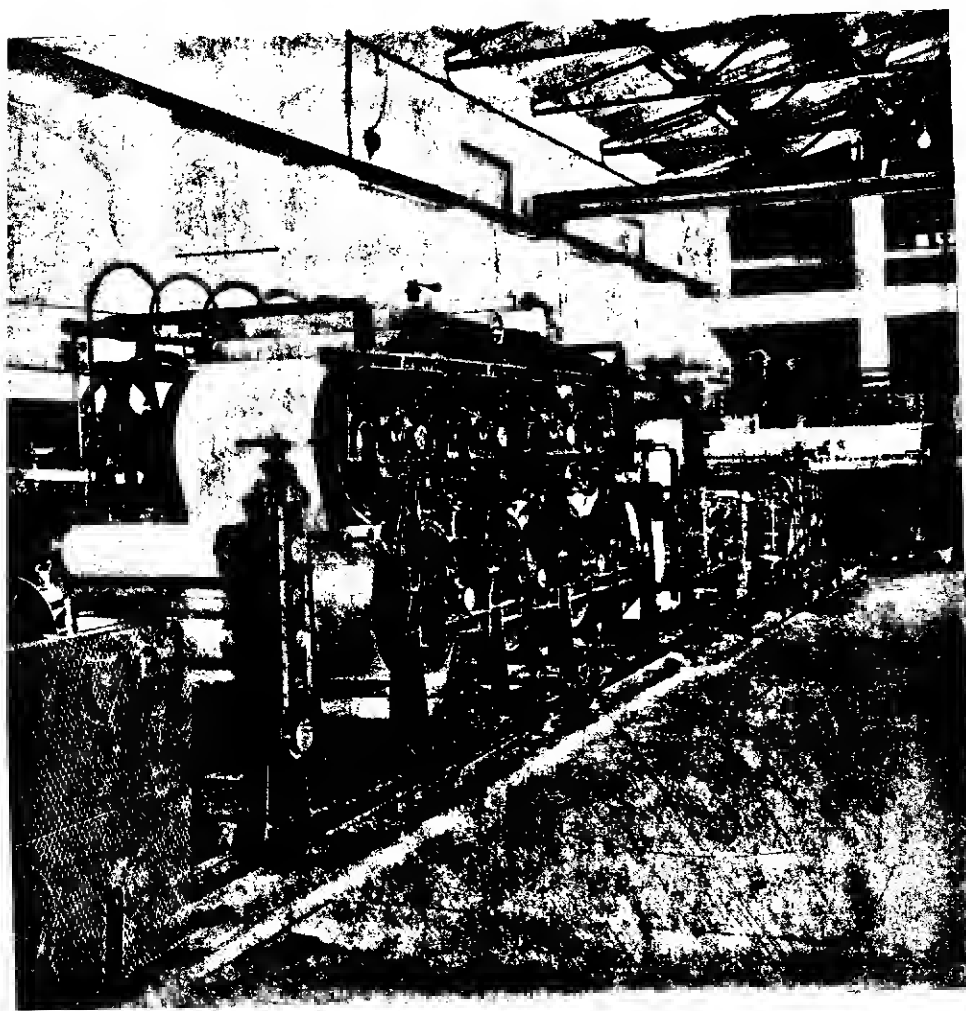
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[This Report is printed on paper made in the Paper Pulp Section of the Forest Research Institute, Dehra Dun, from mixed species of bamboos.]

# FOREST RESEARCH IN INDIA, 1937-38.

## PART I.—THE FOREST RESEARCH INSTITUTE.

### CHAPTER I.—GENERAL REVIEW.

The number of enquiries received continues to increase, more particularly in respect of utilisation subjects, interest in which has been greatly stimulated by the issue of a series of booklets and posters by the Timber Development branch.

Action was taken during the year to bring into effect the resolutions of the Utilisation Conference held in March 1937, and all the resolutions have received attention.

The Tariff Board visited the Institute twice during the year, once in connection with the utilisation of bagasse for fibre boards, and the other time in connection with the Paper Pulp protective duty enquiry.

During the year the Forest Research Institute, at the request of the Punjab Forest Department, co-operated in staging an attractive forest exhibit at the Industrial Exhibition held at Lahore during the cold weather 1937-38. A most attractive pavilion in the shape of a Himalayan temple was built by the Punjab Forest Department. The Forest Research Institute co-operated by supplying exhibits of panelling, parquet flooring, furniture, and numerous displays demonstrating the research work of the Institute.

*Research, Dehra Dun.*—An important event of the year was the visit to the Institute of the British and foreign delegates attending the Silver Jubilee session of the Indian Science Congress at Calcutta. A message, expressing the warm appreciation of all the delegates who had been at the Institute, was subsequently received from the President of the Congress.

Among numerous visitors to the Institute mention may be made of Mr. B. C. L. Jarvis of Messrs. Hitchin's Jarvis & Co., London, who came in connection with the Pomilio process of pulping raw materials, of Mr. Hof of Messrs. J. M. Voith & Co., to examine the working of the mechanical pulp grinder, of Mr. Maronne, General Manager the Mysore Paper Mills Co. Ltd., to study the

working of the fractional process of digestion for bamboos, and of Col. R. N. Chopra, I.M.S., Director of the School of Tropical Medicine and Hygiene.

To maintain closer contact between the Institute and the Provincial Forest Departments, and to enable officers better to keep in touch with what is going on in the world of forestry, a Research Demonstration course has been instituted. The first Course was held in October 1937 and was attended by some 15 officers, representing nearly all the Provinces. Judging by the opinions expressed by those attending, the Course was much appreciated. It is hoped to make the Course an annual one.

An important step taken to promote contact between the Forest Research Institute and Industry and in the development of the uses of wood, particularly of treated woods, has been the placing of the recently created Timber Development Section under the charge of a separate officer. This officer's chief functions are to advise on practical problems of utilisation and the dissemination in popular language of all available information on the uses of Indian timbers. Besides visits paid by him to the more important industrial centres where he was able to make contact with engineers and those engaged in the wood industries, he prepared and issued some 18 booklets which aroused a great deal of interest and led to many enquiries for designs and technical data.

*Silvicultural Branch.*—Work continued according to the triennial programme and good progress was made. The seed year was, in general, a rather poor one but early and regular rains resulted in a good growing season. Frost, as usual, though milder than in recent years, did a great deal of damage to young crops.

Routine work on seed testing and artificial regeneration trials was continued and a considerable amount of useful information obtained in respect of species which are of special interest to the provinces.

The main subjects under investigation are different methods of thinning, effects of root competition and early spacing, inheritance of racial characters in trees as a preliminary step towards selection and breeding of the varieties with the most valuable characteristics, studies in bamboo management, pruning, effects of controlled burning and comparative experiments in different methods of propagating the more important tree species.

One clear result which has come out of the All-India Teak Seed Origin plots at Dehra Dun is the great differences in frost hardiness between teak from different parts of India and Burma.

Teak from Northern Burma is particularly frost hardy, whereas plants raised from seed from Travancore, Madras and South Bombay are most susceptible to frost damage, other origins being intermediate in their resistance to frost.

On the statistical side, field parties were sent to Coorg, the Andamans and the United Provinces for laying out statistical plots, collecting volume and heartwood data and laying out a number of sets of comparative thinning plots. Routine computation of sample plot files sent in by the provinces was continued, 487 plots being dealt with in the year. The compilation of data for an All-India Teak Plantation Yield Table was commenced, provisional curves for Nilambur being issued. A yield table for willow (*Salix alba*) in Kashmir was compiled.

The publication of notes on general subjects and of results of investigations has been held up owing to pressure of routine work, but two Indian Forest Records (Silviculture Series) came out during the year, one on "Seed weights, germination and plant per cents" for 505 different species grown in India, and the other on "The formation of heartwood and its amount in deodar timber".

In the museum, progress has been made on a model illustrating the working of forest under the "coppice with standards system", and a model showing the zonation of forest types with altitude in northern India was completed. A portable working model showing the effects of erosion when hill sides are denuded of forest cover was lent to the Lahore exhibition. A large number of lantern slides and photographs were lent to industrial exhibitions, educational institutions and others for illustrating popular or scientific lectures. A good collection was exhibited at the Jubilee Session of the Indian Science Congress at Calcutta. The photo section is, however, unable to keep up with all such demands owing to shortage of staff.

The record section has greatly extended in recent years, and in the year under report larger numbers of technical enquiries were replied to than ever before. This function of the Silviculturist as an information bureau is taking up an increasing amount of his time to the detriment of other work.

*Botanical Branch.*—A paper by Mr. Parkinson dealing with 5 species of the Dipterocarpaceæ was published during the year. It is hoped to publish shortly a further paper by the same author on the two Indian Dipterocarpaceæ, *Dipterocarpus indicus* and *Dipterocarpus bourdillonii* as also one on Indian *Bambuseæ*. Two papers

by Dr. Bor were submitted for publication during the year. One paper dealing with the known grasses of Assam, including several species new to science, the other on the synecology of the Aka Hills, Assam, a region about which our botanical knowledge is very meagre.

Large numbers of botanical specimens continue to be received for identification and while this work occupies a great deal of the time of the staff, they are none the less welcome and are very valuable in filling up lacunæ in the herbarium. More than 2,800 specimens were so incorporated in the herbarium during the year. Some 262 specimens were distributed to other herbaria as donations or exchanges. A number of specimens were also loaned out to specialists engaged on the study of various plant groups. Numerous requests for authentic samples of seed were received during the year and several hundred packets of seeds were so supplied to the Provincial Forest Departments and to various botanical institutions within India and in other countries with whom exchange relations are maintained.

Linear Increment plots, laid out in Madras and Coorg in the evergreen forests with the object of studying the structure and content of these forests and also the life of the individual species, were visited by the Forest Botanist during the past cold weather and some 7,000 trees were identified or specimens taken for study.

The investigations on shisham (*Dalbergia sissoo*) root disease and seven species of *Peridermium* occurring on Indian conifers have been completed and papers on them are being prepared for publication.

The fungal diseases which cause widespread unsoundness and mortality of sal trees (*Shorea robusta*) in Bengal, Bihar and United Provinces are at present engaging the attention of the Mycologist. A number of such fungi were collected and identified during his tour in the Bihar and North Bengal sal forests. The factors which predispose the trees to infection by these fungi are being studied with the object of discovering some protective means. A histological study of sal mycorrhiza is now being undertaken.

A preliminary test of the toxicity of Ascu and of creosote has been carried out and further experiments on these preservatives are being continued.

*Entomological Branch.*—The most important part of the year's work was again the study of the parasites of defoliators of teak, sissoo and mulberry. An insectary has been maintained at Nilambur to study the defoliation of teak and the parasites of the

defoliators. An interesting feature of this work has been the successful transference of parasites from Burina to the teak plantations at Nilambur, the parasites being shipped in cold storage to Madras and thence by parcel rail in Nilambur. Lists of desirable and undesirable plants as factors in the control of *puera* and *machaeralis* have been compiled and will shortly be published as the result of ecological surveys carried out in these teak plantations. A project to distribute and colonise the parasites of sissoo defoliators in the Punjab sissoo plantations will be undertaken in the coming year. Colonies of parasite—*Cedria paradoxa*, reared at Dehra Dun on the mulberry defoliator—*Margaronia pyloalis*, were transported to the Changa Manga plantations, some 15,700 parasites being released in June and 20,600 in November. The fauna of lantana was studied at Dehra Dun throughout the year, some 50 species of the insect pests of this weed being investigated. It is estimated that over 400 species of insects visit lantana. It has been established that the lantana seedfly, introduced to Bangalore it is believed in 1921, and which has since spread over the whole country—is of no importance in preventing the germination of fallen lantana berries.

Although no field work was undertaken by the Forest Research Institute, large collections of sandal insects were identified for the Madras Forest Department. Studies in the seasonal incidence and distribution of the Heteroptera of sandal were completed with the examination of the remaining 1,600 specimens, which added 25 species to the insect fauna of sandal.

The Entomologist completed a very thorough study of the bostrychid wood borers which are pests of sawmills and factories.

The staff of the Systematic Section was busily engaged in the arranging, identifying and summarizing data on large numbers of insects sent in by forest officers, collected on tour and reared in the insectary. Specialists in other countries continue to give their assistance. 351 Indian species were added during the year to the reference collection. Descriptions of 44 new species of *Crosso-tarsus*, Platypodidae, were published as an Indian Forest Record.

*Utilisation Branch.*—The year was a very busy one for the Utilisation Branch. The number of enquiries shows an increasing interest in utilisation subjects. The booklets issued by the Timber Development branch stimulated interest in timber structures generally and treated woods particularly and a great deal of the time of the Utilisation Officer was spent in supplying information on these subjects. During January 1938, the Utilisation Officer

undertook an extensive tour visiting Bombay, Madras, the West Coast, Ootacamund, Cuttack, Tatanagar and Calcutta.

In the Timber Testing Station, some 30,000 tests and nearly as many experiments were carried out during the year. 9 new species of timber were tested to determine their strength properties and poles of 4 species were tested for their suitability for electric transmission, telegraph and telephone lines. The increased interest now being taken in civil aviation in this country resulted in the submission of an unusually large number of glue joints for testing in this section.

The number of kilns in operation and under construction in this country continues to increase in response to the demand for seasoned wood. A large number of enquiries in this connection was dealt with by the Seasoning Section, designs and plans for the installation of these kilns being drawn up and supplied to the enquiring firms. Efforts are being directed to improve on the present design of the furnace kiln with a view both to simplify its construction and operation and also to avoid the slight superficial discoloration of the dried wood which results from the hot combustion gases coming directly into contact with the wood. Equipment for an improved design of this type of kiln, which will admit of indirect heating, has been worked out and is now on order.

There is a very definite demand for a simple and cheap type of kiln and one of the aims of this Section is to design such a kiln—preferably one requiring no steam or motive power, which will cost not more than Rs. 1,000 to construct.

Attention continues to be given to the seasoning of railway sleepers. An investigation into the air seasoning of chir (*Pinus longifolia*) sleepers has been started in the East Almorah division of the United Provinces. A small experiment in the seasoning of M. G. sal (*Shorea robusta*) sleepers a year before use was also started in co-operation with the Rohilkhand and Kumaun Railway.

Another important investigation started during the year in this section has been the seasoning for a manufacturing trial of Indian woods for hand and power loom shuttles. A number of indigenous woods have been tried in the past for these purposes but have been found unsuitable, mainly on account of defective seasoning. Blocks of kiln dried samples of *Anogeissus latifolia* have already been sent out for trial, and similar blocks of other species will be sent out as soon as the necessary supplies are received and have been kiln dried. Amongst other investigations in hand in this Section

may be mentioned that of finding indigenous woods suitable for use as battery separators, all of which are at present imported from America.

In the Paper Pulp Section, amongst the more important experiments carried out in the experimental factory were those on the production of kraft paper from *Dendrocalamus strictus* and of printing and writing papers from *Saccharum munja* (munj grass) and *Cymbopogon coloratus* (botha grass). With the installation of the wood pulp grinder, investigations were started into the production of mechanical pulp from *Broussonetia papyrifera* (Paper mulberry), chir (*Pinus longifolia*) and spruce (*Picea morinda*). The first results were not very satisfactory, the pulp being short in fibre and of a brownish colour. A number of adjustments to the plant are being made and the experiments will be continued. The preparation of a cheap printing paper using a mixture of bamboo chemical pulp with mechanical pulp of various softwoods will be tried out. In the laboratory a number of grasses were tested for their suitability for paper making. A large scale test on one of these grasses—*Anthisturia gigantea* (ulla grass)—has been arranged to be carried out at the Lucknow Paper Mills. A series of experiments was carried out on the production of kraft paper from *Pinus longifolia* and *Dendrocalamus longispathus*. The tear and burst factors in the case of both these species compared favourably with those of imported kraft paper. The investigation into the causes of discolouration of pulps has been held in abeyance pending the appointment of a chemist. The experiments on the production of insulation and wall boards from bagasse—undertaken on behalf of the Imperial Council of Agricultural Research—were commenced towards the close of the year. The services of Mr. Bhargava, the Officer in charge of the Section, were again in much request by paper mill owners and by those contemplating erection of new paper mills.

The Wood Technologist continued his work on the preparation of hand lens keys with low power photomicrographs for the identification of the more important commercial timbers of Bengal and Assam. Some 81 specimens were received from these Provinces. Studies on the formation of growth rings in some 12 important species were continued. Of other investigations undertaken by him may be mentioned, the anatomical study of the gurjans and allied timbers, the best method of tapping *Sterculia urens* for its gum (*karar*), the effect of resin tapping on the chir tree, and the relationship between the anatomical structure and the physical properties of teak (*Tectona grandis*). In addition some 320

identifications of woods were carried out on behalf of various Government Departments, public bodies, the trade and others.

In the Wood Preservation Section, service tests were started on fence posts and poles treated with Ascu and creosote for comparing their relative preservative values. An investigation was also started to see if the Madison method of treating green sapling posts by means of motor tyre tubes could be used with advantage on Indian woods. If successful this process would save much wastage which occurs in the forest and during transit by the attack of boring insects and of fungi. An open tank treatment with Ascu for posts and sapwood billets was tried and proved successful. Various proprietary wood preservatives and treated fibre boards were received for testing against termites and other destructive agents. The study of the movement of preservatives in wood, with special reference to Ascu and creosote, was started during the year under review. The investigation of the causes of the erratic permeability of chir (*Pinus longifolia*) to preservatives is in progress. A further series of experiments on the mechanism of the fixation of Ascu in wood has been taken in hand. The work in this connection and the effect of soil salts on the leaching of Ascu is being continued.

Owing to the Assistant Minor Forest Products Officer, being required to assist the Utilisation Officer as personal assistant, the activities of the Minor Forest Products Section were largely confined to the answering of enquiries, the up-keep of the minor forest products garden and the maintenance of records. Of the more important enquiries in this section may be mentioned those in connection with the F. R. I. charcoal kiln of which there are now 25 in operation, charcoal briquetting and the cultivation of medicinal and insecticidal plants.

In the Wood Workshop and Veneer Sections chief attention was again paid to the work in plywoods and veneers, the interest in which, on the part of the trade is shown by the very large number of enquiries received in this connection. The working qualities of a further 10 species of indigenous timbers were investigated and 3 further species were peeled for tests under Project VIII.

*Chemical Branch.*—During the year under report *Vitex peduncularis*, which is a reputed remedy for blackwater fever, has been investigated and an active constituent has been isolated which is being examined pharmacologically.

The study of the Indian fish poison plants has led to the discovery that rotenone, the toxic constituent of *Derris*, is present in

*Millettia pachycarpa* and *Tephrosia candida*. *Millettia* and *Tephrosias* occur in abundance in some of our forests and the fact that wild plants have yielded rotenone is a matter of considerable importance and economic value, since it might be possible to improve the toxic constituents with cultivation.

The work on oils and fats has indicated that *Actinodaphne angustifolia* and *Litsea citrata* are further sources of Lauric Acid which in recent years has become so valuable.

*Timber Development Branch.*—The first activity of the new Timber Development Branch was the compilation of a number of popular propaganda booklets which were printed and released during the year. More than 26,000 copies were distributed free to the general public, business firms, Government Departments, etc. They created a great deal of interest and led to a large number of enquiries regarding timber structures and treated woods. In conjunction with the Timber Testing Section, designs and specifications were drawn up for a number of timber structures, such as wooden bridges for spans from 50 to 70 feet, roof trusses 20 to 60 feet spans, portable huts and watch towers. The Timber Development Officer himself undertook an extensive tour, visiting the larger industrial centres and interviewed a number of business firms, engineers and others interested in the use of timber.

## CHAPTER II.—SILVICULTURE BRANCH.

## I.—Experimental Silviculture.

## (i) NATURAL REGENERATION.

The study of annual seed production and fertility of individual *Anogeissus latifolia* trees (Expt. No. 44) was continued for the 10th year. It was not a good seed year and two out of four sample trees did not produce seed. Germination per cent. for the seed collected ranged from 28 to 59.

Seed crops from individual trees of *Shorea robusta*, *Tectona grandis*, *Pinus longifolia* and *Terminalia tomentosa* were also observed and recorded. Except *Shorea robusta* it was not a good seed year for others. None of the *T. tomentosa* trees under observation produced any seed.

## (ii) INVESTIGATIONS ON SEEDS.

(a) *Seed weighments and germination tests*.—During the year under report 102 weighments were made including 5 new species, and germination tests for 102 species were carried out. Indian Forest Records, Silviculture Series, Vol. II, No. 5, published in 1937, incorporated most of the data collected in previous years.

(b) *Seed storage*.—The following results of germination tests with seed stored for different periods in (i) sealed tins and (ii) gunny bags were obtained. The statement includes species under trial since 1932.

Species.	Date of collection.	Date of first test.	GERMINATIVE CAPACITY.										
			Fresh.	STORED IN TINS FOR					STORED IN GUNNY BAGS FOR				
				1 year.	2 years.	3 years.	4 years.	5 years.	1 year.	2 years.	3 years.	4 years.	5 years.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
<i>Acacia arabica</i> . . .	June 1936 . .	July 1936 . .	54	51	..	Nil	..	..	40	..	..	..	..
<i>Acacia catechu</i> . . .	June 1932 . .	June 1932 . .	67	25	2	1	..	..	1	Nil	..	..	..
	February 1934 .	April 1934 . .	56	14	6	1	..	..	—	—	—	—	—
<i>Acacia modesta</i> . .	May 1933 . .	June 1933 . .	72	57	15	13	9	—	22	4	7	4	—
<i>Adina cordifolia</i> . .	June 1935 . .	June 1935 . .	79*	291*	22*	..	..	..	595*	—	—	—	—
<i>Bombax malabaricum</i> .	April 1932 . .	May 1932 . .	52	36	37	1	4	—	0.7	Nil	—	—	—
<i>Cassia siamea</i> . . .	May 1933 . .	August 1933 .	39	78	4	12	1	..	9	Nil	—	—	—
	March 1933 . .	April 1933 . .	1	—	—	—	—	—	4	10	8	..	..
<i>Cedrela toona</i> . . .	May 1935 . .	June 1935 . .	21	Nil	—	—	—	—	Nil	—	—	—	—
<i>Chickrassia labularis</i> .	March 1933 . .	April 1933 . .	23	3	Nil	—	—	—	Nil	—	—	—	—
<i>Collis tetrandia</i> . .	September 1935 .	October 1935 .	25	30	17	..	..	..	23	1	..	..	..
<i>Dalbergia latifolia</i> . .	May 1933 . .	June 1933 . .	48	18	Nil	—	—	—	Nil	—	—	—	—
<i>Diospyros tomentosa</i> .	May 1935 . .	May 1935 . .	44	15	4	..	..	..	16	—	—	—	—
<i>Dendrocalamus strictus</i> .	May 1933 . .	June 1933 . .	65	73	75	49	16	..	0.6	Nil	—	—	—
<i>Hovenia dulcis</i> . . .	April 1935 . .	April 1935 . .	57	48	15	..	..	..	52	2	Nil	..	..
<i>Melia azedarach</i> . . .	February 1932 .	April 1932 . .	65	90	71	68	54	22	60	2	—	—	—
<i>Morus alba</i> . . . .	June 1936 . .	July 1936 . .	5	20	..	..	..	..	8	..	..	..	..
<i>Ougeinia dalbergioides</i> .	May 1935 . .	May 1935 . .	47	Nil	—	—	—	—	Nil	—	—	—	—
<i>Schleichera trijuga</i> . .	August 1932 . .	August 1932 .	13	15	19	Nil	—	—	15	4	Nil	—	—
<i>Svetlenia macrophylla</i> .	January 1936 . .	July 1936 . .	78	70	..	..	..	..	Nil	—	—	—	—
<i>Terminalia arjuna</i> . .	May 1935 . .	May 1935 . .	67	14	Nil	—	—	—	40	7	..	..	..
<i>Terminalia chebula</i> . .	February 1933 .	June 1933 . .	Nil	0.7	0.3	Nil	—	—	1.3	0.7	Nil	—	—

\* Per 1/4th oz. of seed ; ( — ) discontinued ; ( .. ) continued.

Similar storage tests have been commenced during the year for *Chlorophora excelsa*, *Ougenia dalbergioides*, *Olea glandulifera*, *Pterocarpus dalbergioides*.

### (iii) INVESTIGATION ON SEEDLINGS.

The morphological seedling studies were discontinued as they were no longer considered necessary.

### (iv) INVESTIGATIONS ON TREES AND CROPS.

(a) *Seasonal course of height growth*.—The investigation was continued for 14 common Indian species, weekly or periodical measurements being taken throughout the year. Observation was also commenced on *Araucaria cunninghamii*.

(h) *Phenological data*.—Observations were recorded on 14 common species in collaboration with the provinces, and a note will shortly be issued on the subject.

(c) *Inheritance of individual characters*.—The *Terminalia crenulata* plots of reputed figured and unfigured origins, and *Pinus longifolia* plots raised for determining the hereditary character of high resin yielding capacity, were maintained with necessary tending operations.

(d) *Inheritance of climatic racial characters*.—The experiment under the All-India teak seed origin dealing with 11 origins was discontinued after recording morphological differences between the plants of different origins. Biometric measurements of leaves of different origins were recorded, analysed and significant differences determined on a comparison of their mean figures. Besides, leaf descriptions of six origins were prepared on the basis of their obvious differences in size, colour, texture, etc., and a key for their determination was compiled by the Botanist. Reported differences in appearance between Burma and local origins of *Acacia catechu* persisted throughout the year.

(e) *Inheritance of physiological race characters*.—The small plantations of different forms of *Butea frondosa* and *Schleichera trijuga* were more or less frosted again this year. They were maintained and morphological differences only studied.

(f) *Soil quality class indicators*.—The ecological quadrats in plantations of the Demonstration Area were maintained and mapping was done as usual.

(g) *Congestion in bamboo clumps*.—The prescribed treatments of different methods of cutting round the periphery, topping and

stripping, etc., were applied to selected clumps of *Dendrocalamus strictus*.

(h) *Root competition*.—The experiments reported on last year were continued on the following species:—

*Shorea robusta*.—(a) Analysis of this year's figures again indicated a significant increase in diameter growth in the plots where root competition was eliminated as compared with the control plots.

(b) The 6' apart line sowings of sal done in 1933 and sown thinly and thickly in alternate lines at right angles to the east to west edge of a crop of big sal poles, to study the effect of competition between seedlings themselves are still under observation. Alternate pairs of lines have been trenched annually to a depth of 18" cutting through all roots from adjoining wood.

Results for (a) and (b) are being analysed.

*Pinus longifolia*.—Same as *Shorea robusta* (a) above.

*Cedrela toona*.—The experiment as reported last year was kept under observation. The root competition from the surrounding growth was eliminated by trenching all round one of the plants in each of the comparable pairs (growing under the same conditions) and isolating them by galvanised iron.

*Phaëbe lanceolata*.—As *Cedrela toona* above.

*Holoptelia integrifolia*.—Same as *Cedrela toona* and *Phaëbe lanceolata* above except that this has been trenched in sets of three plants.

Results.—No significant differences in growth were observed in the case of last 3 species.

(i) *Thinnings in young plantations*.—The five sets of experiments in replicated series in the younger *Pinus longifolia* plantations in the Demonstration area were maintained. As reported last year, the factors under investigation are (i) comparison of different grades and methods of thinnings (C-grade, D-grade and "free thinnings"), (ii) to compare the effects of different dates of first thinning, (iii) to compare the effects of different early espacement on growth and form, (iv) comparison of thinnings to different fixed numbers of stems per acre, and (v) comparison of different thinning cycles. It is too early to report any results so far.

(j) *Prunning versus natural cleanings*.—The two investigations in *Shorea robusta* and *Pinus longifolia* crops into the effects of

prunning versus natural cleaning on growth and timber quality were continued.

(k) *Twist in Pinus longifolia*.—The experiments of (a) attempting to induce twist and (b) studying the heredity of twist in *Pinus longifolia* were continued. Plants raised from X-rayed seed are progressing and will be examined for occurrence of twist as soon as they are large enough for the purpose.

(l) *Controlled burning*.—The experiment on determining the effects of early burning in young *Pinus longifolia* plantations was continued.

#### (v) ARTIFICIAL REGENERATION.

As reported last year the 1936 monsoon had arrived much earlier than usual, in the beginning of June, and continued up to the end of September. There were copious winter rains also in December. Frost occurred, as usual after the winter rains, but was not as severe as in the previous few years. The year was a damp one.

The 1937 monsoon also broke a little earlier than usual,—in the second week of June, and rains were regular up to the 3rd week of September. As in 1936, the plants had a longer rainy season than during previous years. There were a good many lasting showers in the middle and towards the end of winter. These were followed by frost which, though not very severe, was fairly so, and affected some plantations in the experimental garden and demonstration area.

(a) *Line sowings*.—The following species were tried in the open as well as in shade during 1937:—

*Bombax malabaricum*, *Boswellia serrata*, *Celtis tetrandia*, *Cordia myxa*, *Erythrina suberosa*, *Lagerstræmia parviflora*, *Ougenia dalbergioides*, *Terminalia myriocarpa*, *Xylia dolabriiformis*. Of these *Boswellia serrata* and *Terminalia myriocarpa* failed, the others did well. Plants were more or less affected by frost particularly those of *X. dolabriiformis*.

(b) *Rains entire planting in the open*.—The following species were tried in 1937. The survival per cent. at the end of the year is given in brackets. The plants have not yet been through a hot weather:—*Cassia fistula* (40), *Cedrela toona* (78), *Hovenia dulcis* (87), *Morus alba* (99), *Pterocarpus dalbergioides* (86), *Xylia dolabriiformis* (73).

For the species planted in 1936 the following are the survival percentages at the end of the first and second growing seasons respectively.

*Cedrela toona* (74-46), *Holoptelia integrifolia* (78-38), *Lagerstræmia parviflora* (55-50), *Morus alba* (82-6\*), *Machilus gamblei* (96-6\*), *Swietenia macrophylla* (96-10\*) and *Terminalia citrina* (96-58). Casualties were mainly during the hot weather. (Figures marked\* were at the end of the first hot weather, when these particular experiments were closed).

(c) *Rains entire planting in cleared lines under shade.*—The following species were planted in 1937, the survival per cent. at the end of the year being given in brackets:—

*Cassia fistula* (82), *Cedrela toona* (53), *Hovenia dulcis* (96), *Morus alba* (99), *Pterocarpus dalbergioides* (96), *Xylia dolabriformis* (98).

As regards the species tried in 1936, the following are the survival per cent. at the end of the first and second growing seasons respectively:—

*Cedrela toona* (69-48), *Holoptelia integrifolia* (59-38), *Lagerstræmia parviflora* (11-closed), *Lophopetalum fimbriatum* (99-53), *Morus alba* (82-66), *Machilus gamblei* (98-58), *Swietenia macrophylla* (62-2\*) and *Terminalia citrina* (92-44). Casualties were mainly during the hot weather (\* vide note above).

(d) *Winter entire planting in the open and under shade.*—Of the three species planted out during February 1937, two, viz., *Machilus gamblei* and *Morus alba* survived. *Anthocephalus cadamba* died during the hot weather of that year.

The following species were put out during February 1938:—

*Eugenia jambolana*, *Ougeinia dalbergioides*, *Schima wallichii* and *Stereospermum suaveolens*.

(e) *Winter stump planting in open and cleared lines.*—At the end of the first growing season, the survival percentages for *Acacia modesta*, *Hovenia dulcis*, *Litsea polyantha*, *Mallotus philippinensis*, *Pongamia glabra*, *Swietenia macrophylla*, and *Terminalia paniculata* tried in 1937 were 30, 44, 50, 42, 55, 43 respectively in the open.

The following species were planted during 1937-38 cold weather:—

*Acacia modesta*, *Aleurites fordii*, *Bauhinia purpurea*, *Holoptelia integrifolia* and *Terminalia chebula*.

(f) *Rains stump planting in the open.*—The species put out in 1936 are mentioned below with their survival percentages (within brackets) at the end of the first and second seasons respectively:—

*Cassia siamia* (100-52), *Cedrela australis* (100-92), *Cordia myxa* (100-100), *Hovenia dulcis* (44-25), *Lagerstræmia parviflora* (98-90), *Prosopis spicigera* (99-87), *Pterospermum acerifolium* (100-91), *Terminalia paniculata* (98-84). These were all healthy at the close of the year.

With the species tried in 1937 the following results were obtained at the end of the year, the figures in brackets giving the survival per cent.:—

*Acacia modesta* (83), *Cassia siamia* (59), *Holoptelia integrifolia* (100), *Phæbe hainesiana* (90).

(g) *Rains stump planting under shade.*—The species put out in 1936 showed the following survival percentages at the end of the first and second seasons respectively:—

*Cordia myxa* (98-98), *Eugenia grandis* (65-10), *Eugenia operculata* (99-20), *Hovenia dulcis* (70-47), *Lagerstræmia parviflora* (96-88), *Pterospermum acerifolium* (98-90), *Terminalia paniculata* (88-50), *Terminalia tomentosa* (88-68). Of these only *Eugenia grandis* almost died out in the second year of drought and frost.

The following species were tried in 1937, their survival per cent. at the end of the season being given in brackets:—

*Acacia modesta* (88), *Cassia siamea* (22), *Diospyros tomentosa* (88), *Holoptelia integrifolia* (96), *Phæbe hainsiana* (98), *Swietenia macrophylla* (46), *Terminalia citrina* (65).

(h) *Storage of stumps before planting.*—The 1936 experiments with *Cedrela toona* and *Terminalia tomentosa* stored in moist sacking under thatch shelter for 0, 4, 7, 10 and 13 days showed the following results at the end of the second growing season:—

*Cedrela toona.*—The survival percentages were 56, 58, 60, 78 and 58 with corresponding average heights of 27·2", 27·4", 31·1", 29·2" and 30·1".

*Terminalia tomentosa.*—The survival percentages were 48, 46, 42, 42 and 44 with corresponding average heights of 19·5", 26·0", 24·0", 26·2" and 24·3".

In 1937, *Dalbergia sissoo* and *Terminalia tomentosa* were tried under similar conditions.

*Dalbergia sissoo*.—250 stumps of different diameters prepared on the 10th June 1937 were planted out in comparable sets of 50 stumps after storage up to 13 days in moist sacking under thatch shelter. Rains continued during the planting periods and also afterwards. At the end of the growing season the survival percentages were 98, 100, 100, 96 and 100 with corresponding average heights of 13.1", 12.5", 12.8", 12.6" and 13.3" for stumps stored for 0, 4, 7, 10 and 13 days respectively.

*Terminalia tomentosa*.—The number of stumps and the initial treatment were the same as for *Cedrela toona*, but the date of preparing the stumps was the 13th June 1937. At the end of the year the survival percentages were 98, 100, 100, 100 and 100 with corresponding average heights of 22.7", 20.9", 22.8", 20.8", 20.4" for stumps stored for 0, 4, 7, 10 and 13 days respectively. Rains were continuous up to the end of the month.

(i) *Early planting of stumps without irrigation*.—The fortnightly planting of 25 *Bombax malabaricum* stumps was started from the 5th January 1937, in the open and was continued up to the 23rd June 1937. The survival percentages at the end of the year were 100, 96, 96, 100, 96, 92, 100, 92, 88, 92, 96, 88 and 80 with corresponding average heights of 13.8", 13.8", 14.3", 14.3", 13.1", 11.0", 14.2", 11.7", 12.8", 11.8", 10.7", 12.1" and 13.9" for 1 to 13 sets respectively. Occasional showers of rain during the planting periods were helpful and the results are fairly uniform without shewing any very marked superiority of any particular date for stump-planting *Bombax malabaricum*.

(j) *Comparison of nursery stock and natural seedlings*.—Nursery and forest plants of *Cedrela toona* were tried this year and at the end of the first growing season the survival percentages were 88 for nursery and 84 for forest plants with corresponding average heights of 4.6" and 3.3" respectively. This again confirms previous year's results with *Eugenia jambolana* that, if transplanted, forest plants suffer by comparison with plants raised in the nursery.

(k) *Comparison of nursery and forest stumps*.—*Bauhinia variegata* and *Eugenia jambolana* planted in 1936 showed at the end of the 2nd year survival percentages of 94 and 80 for nursery stumps, and 68 and 76 for forest stumps respectively; their average heights being 40.4" and 13.1" for *Bauhinia* stumps and 24.5" and 13.0" for *Eugenia*.

(l) *Delayed date of planting stumps*.—During the rains of 1936 trials were made with *Acacia catechu* and *Cedrela toona*,—stumps

having been prepared on the respective dates of planting. The planting commenced on 13th June 1936 and was continued at weekly intervals until 11th July 1936, i.e., 5 sets of 25 stumps each time, stumps being graded into 0.1" diameter classes. The following statement gives their survival percentages (numerators) with corresponding average heights (denominators) at the end of the first and second seasons:—

Species.	SURVIVAL PER CENT. WITH CORRESPONDING AVERAGE HEIGHTS.									
	Set 1 of 13-6-36.		Set 2 of 20-6-36.		Set 3 of 27-6-36.		Set 4 of 4-7-36.		Set 5 of 11-7-36.	
	1st year.	2nd year.	1st year.	2nd year.	1st year.	2nd year.	1st year.	2nd year.	1st year.	2nd year.
<i>Acacia catechu</i>	$\frac{88}{18.4''}$	$\frac{84}{59.9''}$	$\frac{96}{16.1''}$	$\frac{88}{56.5''}$	$\frac{36}{13.1''}$	$\frac{32}{57.1''}$	$\frac{Nil}{0}$	$\frac{Nil}{0}$	$\frac{72}{13.6''}$	$\frac{68}{55.1''}$
<i>Cedrela toona</i>	$\frac{100}{15.2''}$	$\frac{92}{36.7''}$	$\frac{100}{15.4''}$	$\frac{92}{34.7''}$	$\frac{88}{12.1''}$	$\frac{60}{28.5''}$	$\frac{25}{7.4''}$	$\frac{16}{25.3''}$	$\frac{76}{8.1''}$	$\frac{44}{30.2''}$

In the above experiment the rains commenced from 21st June with premonsoon showers on 13th, 15th and 17th.

In 1937 the experiment was repeated with *Dalbergia sissoo*. The operations were the same as in 1936. The planting commenced on 10th June 1937 and was repeated weekly until the 5th set was planted on 6th August 1937. Survival percentages at the end of the first season were 100, 100, 100, 100 and 100 with their corresponding average heights, as 17.7", 16.2", 15.9", 15.0" and 10.1" for each set respectively. The rains commenced from June 20th with premonsoon showers on 9th to 11th and on 14th.

(m) *Comparison of sowing, transplanting and stumping.*—In continuation of last year's statement, results for the species under trial since 1935 to date are mentioned below including the survival percentages of the older plants with their corresponding average

heights at the end of 1937. Each operation was done at the season which, as far as known, was the most favourable for it:—

Year of planting or sowing.	Species.	Method (sowing or planting).	SURVIVAL PER CENT. AT THE END OF THE YEAR.			Average height at the end of 1937. (inches).
			1935	1936	1937	
1935	<i>Acacia catechu</i>	Direct sowing	63	75	50	58.1
		Entire transplanting	68	45	25	49.3
		Stump planting	78	65	30	60.8
	<i>Bombax malabaricum</i>	Direct sowing	70	..	..	..
		Entire transplanting	98	50	88	13.3
		Stump planting	90	90	88	32.1
1936	<i>Acacia catechu</i>	Direct sowing	..	95	65	50.5
		Entire transplanting	..	70	48	32.8
		Stump planting	..	88	52	58.5
	<i>Bombax malabaricum</i>	Direct sowing	..	100	88	12.4
		Entire transplanting	..	95	40	10.8
		Stump planting	..	98	95	18.8
	<i>Cedrela toona</i>	Direct sowing	..	80	13	23.2
		Entire transplanting	..	95	8	22.7
		Stump planting	..	100	90	44.0
	<i>Celtis tetrandia</i>	Direct sowing	..	30	..	..
		Entire transplanting	..	88	30	33.8
		Stump planting	..	100	80	38.3
	<i>Dalbergia sissoo</i>	Direct sowing	..	..	83	4.8
		Entire transplanting	..	..	65	8.5
		Stump planting	..	..	95	17.9
	<i>Morus alba</i>	Direct sowing	..	..	85	6.6
		Entire transplanting	..	..	98	15.9
		Stump planting	..	..	90	11.8
	<i>Pterospermum acerifolium</i>	Direct sowing	..	..	95	4.5
		Entire transplanting	..	..	88	4.2
		Stump planting	..	..	100	3.7

(n) *Branch cuttings*.—In the rains of 1936 *Morus alba* branch cuttings were planted in crow-bar holes. These cuttings were 12" long and their diameters ranged between 0.3"-0.6". Their survival percentages were 74 and 46 at the end of the first and second growing seasons with corresponding average heights of 13.9" and 53.3" respectively. The experiment was repeated in 1937 with *Morus alba*, but this time the cuttings were graded into diameter

and length classes, and 50 such branch cuttings of each set were planted. Results at the end of the first season were as follows:—

Set No.	Diameters of cuttings.	Length of cuttings.	Survival per cent.	Average heights.
I	0.3" — 0.6"	9"	28	13.1"
II	0.4" — 0.8"	12"	36	12.2"
III	0.5" — 0.8"	18"	46	15.9"
IV	0.6" — 1.1"	24"	28	19.4"

(o) *Propagation from lateral root systems.*—In August 1935, 50 lateral roots of *Dalbergia sissoo*, arranged in 0.1" diameter classes, ranging from 0.2" to 1.1" in diameter, were planted out in pits, flush with the ground level. Results at the end of first, second and third growing seasons were as follows:—

Season.	Survival per cent.	Average heights.
1st season . . . . .	80	3.8"
2nd season . . . . .	66	23.1"
3rd season . . . . .	66	47.9"

(p) *Number of plants per patch.*—Plants of *Pinus longifolia* raised by patch sowing were later on thinned out leaving 1, 2, 3 and 4 seedlings per patch in a replicated series. The following table gives their progressive annual results to the end of 1937:—

Year.	No. of plants per patch.			
	1	2	3	4
	Average heights in inches.			
1933 . . . . .	9.6	9.7	9.7	9.7
1934 . . . . .	14.2	16.6	16.8	16.8
1935 . . . . .	22.6	23.1	24.3	24.3
1936 . . . . .	37.3	35.9	39.3	39.2
1937 . . . . .	65.3	66.5	69.9	67.2

It would appear that differences in height growth were not significant.

The experiment was repeated with *Acacia catechu* sown in 1935 and thinned to the required number of plants per patch in 1936, and *Bombax malabaricum* sown in 1936 regularised in 1937, and with *Terminalia tomentosa* in 1937 with 2, 3, 4 and 5 plants per patch. Their results are tabulated below:—

Species.	Year.	No. of plants per patch.				
		1	2	3	4	5
		Average heights in inches.				
<i>Acacia catechu</i> . .	1936 . .	29.0	29.1	29.0	29.0	..
	1937 . .	55.4	62.4	63.2	56.4	..
<i>Bombax malabaricum</i> .	1937 . .	9.1	9.0	9.1	9.0	..
<i>Terminalia tomentosa</i> .	1937 . .	..	8.1	8.1	8.4	8.3

(q) *Araucaria plantations*.—The *A. cunningghamii* plantation of 1931 is growing well and has reached a maximum height of 14' at the end of the 6th year.

Plants of *Araucaria bidwillii* mixed with *Pinus longifolia* in 1929 have attained a maximum height of 13' at the end of 8 years. The small plot planted up with *A. bidwillii* during 1936 was maintained with necessary tending operations and the plants look quite healthy and promising with a maximum height of 30" at the end of the last season.

#### (vi) NURSERY WORK.

The seed crop in the forests of the Dun valley was not good during the year. Flowers, seeds and fruits of many species were blown away by one of the heavy storms that occurred in the valley during the month of June and wrought considerable damage. Stock of various species was raised for use in the Experimental garden and Demonstration area.

The following experiments were carried out in the nursery during the year:—

(a) *Experiments with different degrees of nursery bed shades* (Experimental 14) were repeated with *Adina cordifolia* and *Anthocephalus cadamba*.

*Adina cordifolia*.—Results were the same as in previous years in that stocking and development were the best under tin shade, fairly good under thatch, poor under batten and worst in the open.

*Anthocephalus cadamba*.—Germination, stocking and development were the best under batten shade, good under thatch and fairly good under tin and poor and patchy in the open—thus practically confirming last year's results except that results under tin shade were better than under thatch last year.

(h) *The manuring experiment (No. 16) in nursery beds* having the same past history was continued with the seeds of *Morus alba*. *Crotalaria juncea*, *Cassia tora* and *Lucerne* were again used this year as green manure in 3 different beds, whereas artificially prepared farmyard manure was added to two other beds separately at the rate of 10 and 20 baskets per bed as last year; besides three other beds were prepared with 10 and 20 baskets of farmyard manure and *Adco* respectively. One separate bed was kept as control. *Morus alba* was the species used for test and the quantity of seed used for the nursery beds was the same in all cases. The average heights of *Morus* plants for each kind of manure are given below:—

Manure.	Average heights in inches.	Remarks.
1. <i>Crotalaria juncea</i> . . . . .	10·7	Results shew considerable variation year after year.
2. <i>Cassia tora</i> . . . . .	12·1	
3. <i>Lucerne</i> . . . . .	11·2	
4. Artificial farmyard, 10 baskets . . . . .	8·6	
5. Ditto 20 „ . . . . .	10·0	
6. Farmyard manure, 10 „ . . . . .	11·3	
7. Ditto 20 „ . . . . .	9·5	
8. <i>Adco</i> — 10 baskets „ . . . . .	10·4	
9. Control . . . . .	10·0	

*Cassia tora* seems to have given the best results this year. 10 baskets of farmyard manure and all green manures proved decidedly better than the control.

(c) *Best material for seed covering* (Experiment No. 92).—An experiment was conducted to determine the efficacy of various seed covers, viz., (a) well washed coarse sand, (b) sifted decomposed vegetable manure (made using “*Adco*”), (c) farmyard manure and (d) sifted nursery soil, on the rapidity and uniformity of

germination of shaded and unshaded *Kydia calycina* and *Terminalia chebula* seeds.

The data collected were analysed according to the technique of analysis of variance, with the result that the different covers had no significant effect on the maximum germination of the two species whether shaded or unshaded. A significant result however was obtained on the rate and germination in case of unshaded beds, the coverings in order of efficacy being (b), (c), (d) and (a), with no marked difference between (b) and (c).

(d) *Best time for seed collection*.—5 lots of the seed of *Terminalia chebula* collected on 7th December 1936, 15th December 1936, 23rd December 1936, 2nd January 1937 and 11th January 1937 were sown in randomised beds on the same day and under similar conditions. At the end of the year, the survival percentages of plants from seed of different dates of collection were 16, 8, 10, 4 and 4 respectively, with their corresponding heights as 4'4", 4'3", 5'3", 5'1" and 4'6".

#### (vii) MISCELLANEOUS.

A small plantation of *Agathis palmerstonii* has been raised in the Experimental garden. The two small plantations,—one of *Broussonetia papyrifera* raised from branch and stem cuttings and the other of *Hovenia dulcis*, raised by stump-planting last year, were tended. About 42 per cent. of the former have sprouted so far and a few more are likely to follow next rains when casualties will have to be replaced as required. The plants of *H. dulcis* are making good progress with a maximum height of 6 ft. and an average height of 3½ ft., while the survival per cent. is 92.

#### (viii) RECLAMATION AND AFFORESTATION.

(a) *Miscellaneous Working Circle*.—*Acacia catechu*, *Bambusa polymorpha*, *Cedrela toona*, *Dendrocalamus strictus*, *Dendrocalamus longispaxis* and *Morus alba* raised for afforesting the failed teak compartments as mentioned in last year's report were tended during the year. Blanks in existing teak and *Gmelina* compartments were planted up with stumps and entire transplants of miscellaneous species. Thinnings were also done in some of these compartments, combined with pruning in the *Gmelina* crop.

The rosewood plantation in two adjoining compartments has been regularly pruned and the miscellaneous species, chiefly the quick-growing *Broussonetia papyrifera*, removed wherever interfering with the rosewood.

Plants of *Aleurites fordii* and *A. montana* are now fairly established in one of the cleared rosewood compartments. A small plantation of *Celtis tetrandia* was also raised during the year under report. As stipulated last year a 15-acre plot has been sown with *Pinus longifolia* to raise crops for an extensive replicated set of thinning experiments. Five more compartments leased out to *taungya* cultivators will be used up next rains.

(b) *Sal Working Circle*.—Compartments 1, 2, 10 and 11 were thinned. Blanks in some of the compartments were planted up with the stumps of *Cedrela toona*. *Tephrosia vogelii* was sown in C. 12 in connection with Experiment No. 41 (cover crop). Frost occurred this year as usual but damage was limited to small and unprotected plants only. Mixed line sowings of *Dalbergia sissoo*, *Dodonea viscosa*, and *Bauhinia* species, carried out last year were found to have afforded some protection to tender *sal* against light frost.

(c) *Chir (Pinus longifolia) Working Circle*.—The *chir* crops of various origins were kept under observation and all experiments herein were maintained.

## II.—Statistical Section.

### (i) YIELD TABLES.

The total number of existing sample plots (including tree increment plots) to the end of the year was 1,723 against 1,656 of the previous year. 487 plot files were computed during the year while 476 sample plot files (including those for 57 new plots) were received from different provinces for routine computations.

During the year under report the Central Silviculturist with a field party laid out 39 new sample plots in Coorg. A few more were laid out by the Statistical Assistant Silviculturist in the Andamans towards the close of the year.

Yield tables were compiled for the plantation *willow* (*Salix*) from data received from Kashmir. Provincial yield table curves relating to the main crop of Nilambur plantation (Madras) were prepared in connection with revision of the working plan. Enough data were collected and worked out for an all-India teak plantation yield table to be published in the near future.

### (ii) MISCELLANEOUS.

Single tree volume data were computed for *Terminalia tomentosa* for some provinces on the basis of such figures as could be accepted.

### III.—Miscellaneous.

#### (i) PUBLICATIONS.

Two Indian Forest Records of Silviculture Series were published during the year, one on "Seed weights, plant per cents., etc., for forest plants in India" (in revision of Forest Bulletin No. 41), and the other on "The formation of heartwood and its amount in deodar timber", besides a number of contributions from the Branch published in the *Indian Forester*.

A monograph on the silviculture and regeneration of the *Dipterocarpus* spp. is ready for the press, and revision of Forest Bulletin No. 78 on the problem of the pure teak plantation and an All-India teak plantation yield table were partly completed.

#### (ii) PHOTOGRAPHIC SECTION.

Heavy arrears of work which had accumulated in the past have been considerably reduced. The demand for photos and slides, etc., has been steadily on the increase from different provinces, for their industrial exhibitions, educational institutions and others for illustrating popular or scientific lectures. A good collection was also exhibited at the last Jubilee session of the Indian Science Congress at Calcutta.

The total number of prints in the general series comes to 4,561 and in the specific 5,146, against 3,798 and 4,529 respectively for the last year, thus adding a total of 1,380 photographs in the collection during this year against 457 of the previous year.

2,635 prints were prepared for different Provinces, States and educational institutions, and 50 were made for reproduction in various publications. Collection of 16 m.m. films has also been just commenced.

#### (iii) RECORDS.

The documentation part, increasing from year to year, has always been an important routine work of the Branch. Although large numbers of publications (including periodicals) were marked for ledger files during the year under report, there is yet much scope for improvement. In the matter of ledger filing the Branch, with its present limited staff, cannot make proper use of the vast amount of literature received each year. In many cases it can do little beyond referencing them in a general way.

New ledger files opened during the year were 30 under the specific and 16 under general, their totals at the end of the year

being 1,307 and 486 respectively. 67 new books and working plans were added to the library during the year, bringing the total to 786 with 573 bound volumes of periodicals.

Abstracting of all Indian forest literature was continued as usual for the five agencies in India and abroad, and lists of additions of important books with their brief abstracts were circulated to all the provinces.

#### (iv) WORKING PLANS.

Notes were written on two plans under preparation during the year,—one for the Cachar division (Assam) and the other for Hoshangabad (Central Provinces).

#### (v) MUSEUM.

The model illustrating the altitudinal zonation of forest types was completed as well as another new model for the "coppice-with-standards" system. Besides, necessary improvements were made to the older models and enlarged photographs were partly coloured. Fifty selected stereo-photos on a stand were also added to the museum. A portable duplicate erosion model was also completed which was lent to the Lahore exhibition where it attracted considerable notice.

#### (vi) TOURS.

Mr. M. V. Laurie toured in Kumaon in the hot weather in connection with the resin tapping experiments and in the cold weather in Coorg and in Madras. In Coorg he laid out a number of statistical plots.

Mr. M. A. Kakazai, Statistical Assistant Silviculturist, reverted to the United Provinces and was succeeded, on the 17th April 1937, by Bakshi Sant Ram of the Punjab Forest Service who remained thereafter in charge of the Statistical Section throughout the year. He toured in Chakrata (United Provinces) in connection with the remeasurement of sample plots. He was also deputed to the Statistical Laboratory, Presidency College, Calcutta, for a period of 2½ months for a short course under Prof. Mahalanobis. Mr. Sant Ram also represented the Forest Research Institute at the Statistical Conference held at Calcutta under the auspices of the Science Congress, where a paper on "Some practical aspects of the application of statistical theory to silvicultural research" by the Central Silviculturist (Mr. Laurie) was read. He toured with a field party in the Andamans in connection with the sample plot work from February 1937.

## CHAPTER III.—BOTANY BRANCH.

**Systematic Botany.**

A brief reference was made in last year's report to a paper on two South Indian Dipterocarps, *D. indicus* and *D. bourdillonii*, and another on Indian *bambuseæ*. These papers have not yet been completed, but Mr. C. E. Parkinson is still working on them and it is hoped to publish them during the next year.

A paper dealing with five species of the *Dipterocarpaceæ* was published by Mr. Parkinson during the year.

A paper dealing with the known grasses of Assam, including several species new to science, was also completed and submitted for publication.

*Synecology*.—A paper on the synecology of the Aka Hills, Assam, a region about which our botanical knowledge is very meagre, was submitted for publication.

*Identification of specimens*.—1,406 specimens from outside sources were identified during the year, this number includes part of a large collection from the Nilgiris made by the Forest Botanist.

Mention has been made in previous reports of the large number of specimens which are received and identified as a matter of routine and it has been stressed that such identification takes up a large portion of the time of the Forest Botanist and his assistant. This is true but at the same time collections sent in by forest officers from all over India are very welcome; they very often are exceedingly valuable in helping to fill up lacunæ in the herbarium. Material from Madras is greatly desired for although some of the best botanists in the Indian Forest Service worked in the Madras Presidency, this herbarium contains surprisingly few sheets of their collections.

One hundred and seventeen specimens were sent to the Royal Botanic Gardens, Kew, and twenty-two to the Royal Botanic Garden, Calcutta, for identification or for confirmation.

*Herbarium*.—2,837 specimens were incorporated during the year. The more notable totals include Dr. N. L. Bor's 1,179 sheets (Naga Hills, England, Ceylon and Hongkong), M. B. Raizada's 432 sheets (Dehra Dun and Jaunsar), Botanical Forest Officer, Assam's 257 sheets, C. E. Parkinson's 110 sheets (Kumaon, Beshahr, Burma), Director, Melbourne Botanic Garden's 129

sheets, Gray Herbarium's 99 sheets. Dr. Bor's Naga Hill collection was specially welcome as it contained very many species which were not represented in the herbarium. The remainder was made up from the numerous smaller collections and individual specimens sent in by forest officers and others.

The following specimens were distributed in exchange or donations:—

The Principal Botanist, Department of Agriculture, Pretoria, South Africa . . . . .	70
The Director, New York Botanical Garden, New York, N. Y., U. S. A. . . . .	70
The Forest Botanist, Maymyo, Burma . . . . .	117
The Botanical Forest Officer, Shillong, Assam . . . . .	5
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Total . . . . .	262
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Dr. R. R. Stewart, Professor of Botany in the Gordon College, Rawalpindi, worked in the herbarium on ferns for a week.

Rao Bahadur T. S. Venkatraman, Government Sugarcane Expert, Imperial Sugarcane Station, Lawley Road Post, Coimbatore, consulted the collection of grasses.

Professor S. A. Akhtar of Kabul worked for sometime in the herbarium on his Afghanistan specimens.

*Library*.—Forty-six books and fifty-seven volumes of periodicals were added to the library during the year.

*Tours*.—Mr. C. E. Parkinson undertook a three weeks' tour in the Simla Hill States during the month of June in order to find the "aromatic sage" of Fraser, which is believed to be the "soma" plant of Hindu mythology. He travelled over Fraser's route and came to the conclusion that the "aromatic sage" could be no other plant but *Meriandra strobilifera*.

The Forest Botanist toured in Madras and Coorg for six weeks in November-December in order to identify the trees standing on the linear increment plots laid out by the Silviculturist, Madras. About 7,000 trees were dealt with.

Mr. Mukat Behari Raizada visited the Agri-Horticultural Garden, New Delhi, in July to select plants for the Botanical Garden.

Dr. K. D. Bagchee toured in the Chakrata forests in May, June and July in connection with his investigation into Himalayan coniferous rusts. He toured in Bengal and Bihar in January and February in connection with the diseases of the sal tree.

*Seed supply.*—The demand for small authentic samples of seed continues to increase year by year. The list of seeds offered in exchange from the Arboretum and Botanical Garden of the Forest Research Institute was as usual distributed to all provincial forest departments in India and to various botanical institutions in India and abroad with which seed exchange relations are maintained. About 500 packets of seeds were supplied in response to the numerous requests received.

In addition to the above, 31 indents aggregating about 1,150 pounds of seed were supplied during the year. The seeds supplied include a number of exotic species requisitioned by the Central Silviculturist and other forest officers from the provinces. The following seeds were obtained and supplied to them:—

1. *Tephrosia vogelii*, *Pinus caribæa*, *Markhamia platycalyx* and *Chlorophora excelsa* to the Central Silviculturist.
2. European larch (*Larix europæa*), Japanese larch (*Larix kœmpferi*) and Korean larch (*Larix dahurica* var. *Principis Ruprechtii*) for the Divisional Forest Officer, Garhwal Forest division, United Provinces.
3. *Hæmatoxylon campechianum* for the Forest Research Officer, Bihar.

The seeds mostly in demand were:—*Acacia senegal*, *Actinodaphne hookeri*, *Sagera elliptica*, *Cupressus torulosa*, *Chlorophora excelsa*, *Tectona grandis* from Malabar, *Hydnocarpus wightiana*, *Taraktogenos kurzii*, *Eucalyptus naudiniana*, *Cassia auriculata*, *Gmelina arborea*, *Azadirachta indica*, *Pinus excelsa*, *Abies pindrow*, *A. webbiana*, *Bombax malabaricum*, *Semecarpus anacardium*, *Sapium sebiferum*, *Dalbergia sissoo*, *Pinus longifolia*, *Cedrus deodara*, *Acacia arabica*, *Anogeissus pendula*, *Prosopis glandulosa* and *P. juliflora*.

*Botanical Garden and Arboretum.*—During the period under review work in the Botanical Garden continued to make steady progress and the results so far obtained justify the money and labour spent on its maintenance. About 80 plants representing 20 families and 33 genera were planted out during the year. The "Glass House" in which various cacti and succulents are displayed is an attractive and interesting addition to the garden. The rearrangement of the Rose Garden has been a success. The winter and rainy season show of annuals adds greatly to the attractiveness of the garden which is now being visited by an increasingly large number of visitors. The growth of creepers on the Green

House is progressing favourably and as soon as the whole is covered it is proposed to grow shade-loving plants inside it.

In the experimental garden and nursery about 300 plants were raised for planting in the Arboretum and Botanical Garden; in addition to this number about 400 were distributed for planting in residential grounds at New Forest, the adjoining Indian Military Academy and elsewhere in Dehra Dun.

Planting in the Arboretum continued to make good progress, about 90 plants having been planted out during the year. For the improvement of the grounds a plot of land west of Trevor road was fenced in and planted up with ornamental species known to do well locally.

*Miscellaneous.*—As usual many enquiries on botanical subjects received from forest officers and others in India were answered and advice given in botanical matters.

### **Mycology.**

*Shisham root disease.*—A paper incorporating the results of this investigation is now ready for publication.

*Sal root disease.*—The Mycologist undertook an extensive tour in Bihar and Bengal where the disease is most prevalent. As a result of his field studies *Polyporus shoreæ* appears to be the common cause of root-rot of sal in both provinces.

*Trametes incerta* which seems to induce a heart-rot of the stems of poorer class sal is apparently restricted to Bihar (Conversion and Hill Working Circles) only.

Of the fungi which cause sap and outer heart-rot *Fomes tricolor* and *F. melanoporus* occur in both provinces but *F. lamaensis* appears to be confined to Bengal.

Pure cultures of these fungi have been established and cultural studies commenced.

A collection of various types of fungi on sal was made during the tour and identified at Calcutta.

The United Provinces sal forests (Gorakpur, Bahraich, Pilibhit, Haldwani, Ramnagar and South Kheri divisions) where sal suffers from various kinds of unsoundness have not been visited as yet, but it is proposed to do so shortly in order to make a comparative study of these diseases.

*Mycorrhizal fungi and associated problems.*—An histological examination of sal mycorrhiza has been made and microscopic drawings prepared. Cultural work is in progress.

It is now proposed to grow sal seedlings in sterile (a) water, (b) soil and (c) *Agar Agar* in order to determine the most suitable media for their growth and for the purpose of inoculations with pure cultures.

The investigations into "damping off" of forest seedlings and the "die-back" of *Gmelina arborea* have had to be omitted from the programme of work for want of time.

*Cultural studies of some fungi attacking coniferous trees and their pathogenecity.*—Saplings of *Pinus excelsa* and *Cedrus deodara* which were inoculated at Chakrata several years ago with pure cultures of *Trametes pini* and *Fomes annosus* respectively have been definitely infected and have produced the characteristic rot. Isolations from them developed the same organisms again.

*The biological relations of the following coniferous rusts have been established with their alternate forms by inoculations and a paper on each is under preparation:—*

*Cronartium himalayense* (= *Peridermium himalayense*).—The third paper dealing with the successful inoculations on pine (*Pinus longifolia*) with the teleutostage from *Swertia* is being prepared. The inoculations from pine to *Swertia* have already been recorded in a previous paper.

*Cronartium ribicola* (= *Peridermium indecum*).—The inoculations from *Pinus excelsa* (*P. indecum*) to *Ribes rubrum* and from *R. rubrum* (*Cronartium ribicola*) to *P. excelsa* have been successfully carried out and the genetic connection between the two rusts determined.

Similarly, *Peridermium orientale* (= *P. complanatum*) on the needles of *Pinus longifolia* has been matched with *Coleosporium campanulae* on *Campanula colorata*; *Peridermium brevius* on needles of *Pinus excelsa*, with *Coleosporium* n. sp. on *Senecio rufinervis*; *Peridermium piceae* on *Picea morinda* with *Chrysomyxa himalensis* on *Rhododendron arboreum*; *Peridermium ephedrae* on *Ephedra vulgaris* with *Hyalopsora* n. sp. on *Athyrium acrosticoides* and *Peridermium abies-pindrowina* on *Abies pindrow* with *Uredinopsis* n. sp. on *Polypodium* sp.

*The undermentioned Himalayan rusts still remain unmatched:—*

*Peridermium cedri* on *Cedrus deodara*, *P. thomsoni* on *Abies pindrow*, *Chrysomyxa piceae* on *Picea morinda*, *Chrysomyxa dietelii* on *Rhododendron lepidotum*, *Peridermium*

*near cerebrum* on stem of *Pinus khasya* and *Peridermium* sp. on needles of *Pinus khasya*.

*Toxicity tests of wood preservatives.*—The preliminary experiments having been completed it is now proposed to use cultures of *Polystictus hirsutus* and *Schizophyllum commune* to test the toxicity of *Ascu* as compared to that of Creosote + fuel oil preservative.

*Routine problem.*—The inoculation of *Dalbergia latifolia*. No further work was done.

*Herbarium.*—A large collection of fungi has been made, identified and added to the herbarium.

*Museum.*—A number of important wood-rots of conifers and broad-leaved hardwoods are being added.

Pure cultures of *Trametes incerta* on sal, *Merulius similis* on *Dendrocalamus strictus* and a dry rot fungus on walnut have been added this year.

## CHAPTER IV.—ENTOMOLOGICAL BRANCH.

## CEDRELA TOONA INSECTS.

The parasitism of *Hypsipyla robusta* was studied by sack-banding toon trees in the New Forest Estate; 18,800 larvæ were collected, the maximum from one tree being 386. The parasites of larvæ of the first and second generations included Braconidæ 4 species, Chalcidæ 3 species, Ichneumonidæ 3 species, Tachinidæ 1 species; the predators were *Opilo discodirus* and *Idgia melanurus*. Ichneumonids parasitised the shoot boring larvæ of the winter generation.

## DALBERGIA SISSOO INSECTS.

The shisham plantations Changa Manga, Chichawatni, Daphar, Khanewal, Miranpur and Shahdara were visited in May to study the extent of parasitism of *Plecoptera reflexa* and other defoliators and to obtain material for breeding in the Dehra Dun insectary. Several hundred thousand caterpillars were despatched from all localities by the Forest Entomologist and by the divisional staff. Unexpected difficulties in transport were encountered and excessive mortality occurred owing to high temperatures and rough handling on the railways; it will be necessary to devise special methods for packing and protection of live insect consignments if transport on a large scale is to succeed. A project to distribute and colonise the parasites of shisham defoliators in the plantations will be undertaken next year.

*Exorista picta*, a tachined parasite of *Plecoptera reflexa*, was studied at Dehra Dun and was carried through 6 generations up to March 1938; parasitism of third and fourth stage larvæ up to 20 per cent. was obtained.

*Trichogramma minutum* from eggs of *Hyblæa puera* was reared on eggs of flour moths. Rearings on incubated *Plecoptera reflexa* were started in December and 5 generations in eggs of the last species were carried through.

## LANTANA INSECTS.

In connection with the problem of controlling lantana by means of its insect pests the fauna of this weed was studied at Dehra Dun throughout the year. Over 50 species were investigated of which 36 species attack the leaves, 10 the soft shoots, 7 the flower buds, 32 the flowers, 13 the young fruits, 10 the mature

fruits and one species bores the woody stems. It is estimated that over 400 species of Indian insects visit lantana.

Most occur only in small numbers of individuals but several species of defoliators and flower or fruit eaters breed continuously on lantana, e.g., *Hypena ignotalis*, which has nine generations a year with a long cold weather brood. The regular breeders are prevented from increasing abundantly by wilt disease and parasites; they are also difficult to rear in an insectary on account of disease, and do not offer much scope for artificial multiplication.

The lantana seedfly, *Ophiomyia lantana*, was, we conclude, introduced to Bangalore in 1921 and has since spread over the whole country. It has 21 generations a year but is parasitised by 8 species of Chalcidoidea. Fruits attacked by the fly definitely germinate and the germination percentage is of about the same order as in unattacked fruits which is very low, less than 15 per cent. The fly cannot be regarded as a factor of importance in preventing the germination of fallen lantana berries. Nor is *Platyptilia pusillidactyla* of any value in checking the fruiting of lantana.

#### MICHELIA CHAMPACA INSECTS.

The champ bug, *Urostylis punctigera*, was maintained on caged trees in the insectary garden. In Dehra Dun it has the same habit as in Bengal of remaining very localised without a tendency to disperse in the nymphal stages. A preliminary search for other species of *Urostylis* and their natural enemies was made in Naini Tal division.

#### MORUS INDICA INSECTS.

The parasite, *Cedria paradoxa*, was reared on *Margaronia pyloalis*, a mulberry defoliator at Dehra Dun and colonies were transported to Changa Manga plantation, Punjab; 15,700 parasites were liberated in June and 20,600 in November.

A survey of the parasitism of *Margaronia pyloalis* in the irrigated shisham plantations of the Punjab was started and about 20 species were obtained but very few have yet been identified.

#### SANTALUM ALBUM INSECTS.

Large collections of sandal insects made in Salem district were identified for the Madras Forest Department. In material taken on field crops in several localities between October 1936 and January 1937, amounting to 7,200 specimens, Jassidæ were poorly represented and Aphidæ and Thysanoptera were entirely absent.

Sticky paper traps each 3' x 4', exposed at heights of 3 to 8 feet in Noganur forest between October 1937 and January 1938 yielded over 5,000 specimens; these were dissolved out of the adhesive and the majority were identified. Thysanoptera comprised 55 per cent. of the total catch; aphids and jassids were rare.

Studies in the seasonal incidence and distribution of the Heteroptera of sandal were completed with the examination of the remaining 1,600 specimens, which added 25 species to the insect fauna of sandal. *Indian Forest Records* were published on the Lygaeidae, Dermaptera and Orthoptera.

No field work was undertaken by the Forest Research Institute.

#### SWIETENIA MAHAGONI INSECTS.

Very little could be done at the Nilambur insectary on *Hyppia robusta* without dislocation of the work on teak defoliators. In Nilambur the shoot-borer appears to be entirely free from parasitism. An egg-parasite, *Trichogramma minutum*, was multiplied and 6,000 were released in mahogany plantations. The data obtained in the Madras sample plots were examined.

*Pagiophlæus longiclavis*, the collar borer, was found to breed also in the thicker shoots of mahogany and its work is liable to confusion with that of *H. robusta* in sample plots. Collar borer attacked plants removed in control operations were regularly analysed at Dehra Dun and it was found that the majority of uprooted plants contains no living borers, emergence having occurred before detection.

#### TECTONA GRANDIS INSECTS.

*Defoliators*.—An insectary was maintained at Nilambur from 1st April 1937 to 28th November 1937 to study the defoliation of teak and the parasites of defoliators.

Through the courtesy of the Forest Department, Burma, their Forest Entomologist maintained an Insectary at Insein for the collection and despatch of teak defoliator parasites to Madras. Fifty-three lots were received at Nilambur transported in cold storage by ship between Rangoon and Madras and thereafter as railway parcels.

About 1,600 *Hyblæa puera* larvæ were exposed in 11 experiments to 3 species of Burmese *Apanteles* but only one generation of parasites was reared and the remaining material was exterminated by bacterial disease of the host.

About 500 *puera* larvæ were used for 3 species of tachinids without establishing the parasites.

*Brachymeria euplææ*, *Cremnops desertor* and *Eucarcelia kockiana* were successfully imported but these species were found to be indigenous.

A species of *Trichogramma* was imported from Burma in 9 consignments and bred up on eggs of *Hapalia machæralis*, *Diacrisia obliqua* and a flour moth. Forty-eight experiments using 5,000 eggs were conducted and at the end of the work about 225 parasites were released.

*Trichogramma minutum*.—Material was obtained from wild egg masses of *Diacrisia obliqua* and from the Mysore Government Entomologist. Twenty-three generations were reared and 9,250 parasites were released at the end of the operations.

*Cedria paradoxa*.—About 1,000 individuals were transported from Dehra Dun to Nilambur in March 1937 and over 5,000 cocoon-colonies representing half a lakh of parasites were produced in the insectary. As hosts for this breeding work 11,800 caterpillars were used. About 40,000 parasites were released in 11 localities in the Nilambur teak plantations and a colony of 500 was successfully shipped to Burma. Recoveries were made in two localities in September 1937 from an alternative host, *Lygropia quaternalis*, on *Helicteres isora*, and cocoons were found in April 1938 on fallen teak leaves attacked by *Hapalia machæralis* in a third locality.

The incidence of parasitism of *machæralis* (fifteen species) and of *puera* (four species) between April and November 1937 was determined by regular sampling; 65 per cent. of the larval parasitism of *machæralis* was due to ichneumonids and 95 per cent. of the parasitism of *puera* was due to tachinids. Bacterial disease was extensive.

Ecological surveys of the miscellaneous trees, shrubs and other vegetation in teak plantations have resulted in the compilation of lists of plants that are (a) desirable because they are food-plants of defoliators that are alternative hosts of parasites of *machæralis* and *puera*, or (b) undesirable because they are alternative food-plants of *machæralis* and *puera* or other pests of teak. Eleven of the desirable plants are factors in the control of *puera* and 46 in the control of *machæralis*. Eight species are undesirable.

*Borers*.—Experiments in the control of *Phassus malabaricus* were undertaken by the Madras Silviculturist using an infestation

of *Trema orientalis*; plugging the borer hole with tar is a satisfactory remedy.

No reference was made in the report for 1936-37 to Dr. Beeson's visit to Burma at the close of the year to advise on entomological research and in particular on the beehole borer of teak, *Xyleutes ceramica*. His recommendations were adopted by the Burma Forest Department and the report was published during the current year.

#### BORERS OF NEWLY FELLED TREES.

The biology of *Platypus biformis* in *Pinus longifolia* was studied in the field in the United Provinces. Poles felled and barked in the winter were surface treated with Ascu in Chakrata division in April and by July were attacked by *P. biformis* except those that had dried out sufficiently to make them unsuitable for the development of the larvæ. Storage of poles in water or rapid drying in the sun are considered to be the best remedies.

In the Insectary many new records were made of borers of timbers from various parts of India and satisfactory progress was achieved in identification.

Poles and logs of *Bombax malabaricum*, *Dalbergia sissoo*, and *Shorea robusta* were felled and barked in Dehra Dun division in March and surface brushed with (a) cold Ascu solution and (b) the same followed by asphalt crude oil suspension heated to 50° C. In November all the treated material showed extensive damage by powder post beetles and (to a less extent) by pinhole borers and termites, demonstrating that surface treatment does not prevent boring by species of which the adult makes an oviposition tunnel within the sapwood.

#### BORERS OF ARMY TOPIS.

Topi pith helmets are attacked by *Rhizopertha dominica* owing to the use of flour paste. Various poisons for use in paste were tested. It was found that sodium fluosilicate, 10 per cent., is as effective as a 3 per cent. solution of arsenic pentoxide and copper sulphate, 3: 1, but is less satisfactory than a 3.5 to 4 per cent. solution of arsenic-copper. These poisons are more effective in protecting topi shapes in the factory than is the plain copper sulphate treatment at present used by army contractors.

#### TERMITES.

Information on the economic importance of termites has been collected from Forest Departments in accordance with the resolution

and questionnaire of the British Commonwealth Scientific Conference, London, 1936.

A project for the investigation of the biology and control of soil termites in collaboration with the Agricultural Research Institute, New Delhi, has been under consideration by the Imperial Council of Agricultural Research throughout the year.

#### PARASITES AND PREDATORS.

General studies have been continued. Special operations involving multiplication and colonisation of selected species are referred to under mulberry, shisham and teak insects.

#### BIOLOGIES.

The greater part of the biology of the Cerambycidae has been written up. Numerous local species of defoliators of trees were bred.

In the Dehra Dun Insectary 128 consignments of insect damage were received from forest divisions. 572 breeding cages were in operation. The total number of insects bred in the insectary was over 77,000, excluding the special parasite rearings and the yield of the field insectaries. 17,352 specimens were mounted and labelled.

*Guides.*—A Guide to the Insects of *Dalbergia sissoo* was prepared and sent to press.

### Systematic Entomology.

#### IDENTIFICATION.

The staff of this section has been steadily occupied in arranging, identifying and summarizing data on the great numbers of insects reared in the insectary, collected on tour, or sent in by forest officers. Numerous specialists in other countries continue to give their assistance. The Imperial Institute of Entomology has arranged for the identification of parasites and considerable headway has been made already. Three hundred and fifty-one Indian species have been added to the reference collection.

#### TAXONOMY.

The collection of identified coleopterous larvae has been considerably extended by rearing experiments and several *Indian Forest Records* have been prepared for publication. A paper on

larvæ of Lymantriidæ, the first of a series proposed for immature stages of Lepidoptera, is in press; the necessary rearing experiments were carried out in the systematic Entomologist's laboratory.

Descriptions of 44 new species of *Crossotarsus*, Platypodidæ, were published as an *Indian Forest Record*.

The collections have been maintained in good condition. A large collection of identified Coleoptera was presented to the Imperial Agricultural Research Institute, New Delhi.

*Tours.*—By Dr. Beeson to Dehra Dun division in October; to Delhi in November (Entomologists' Committee) and in March (Federal Public Service Commission); to Lahore (Sericultural Committee and shisham plantations) in December; to Ranchi (Indian Lac Cess Committee) in March. By Mr. Gardner to Almora East and West and Garhwal divisions in May-June; to Nilambur in July. By Mr. Mathur to Lahore, Montgomery and Multan divisions in May, June and November. By Mr. S. N. Chatterjee to Nilambur, April to November; By Mr. Bhatia to Almora East and West and Garhwal divisions in May, June and Chakrata divisions in July. By Mr. Bhasin to Saharanpur divisions in July.

*Museums.*—Numerous additions were made to the display of damage by wood borers and to ecological and parasitism exhibits in the entomological museum. Reptiles and skins were added to the zoological museum.

*Library.*—158 books besides periodical were added to the Zoological library during the year.

## CHAPTER V.—UTILISATION BRANCH.

## Wood Technology Section.

## 1. RESEARCH.

(a) Work in connection with the preparation of hand lens keys, supplemented with low power photomicrographs, for the identification of the more important commercial timbers of Assam and Bengal was continued throughout the year under review. About 81 timber specimens were received from the above provinces in this connection. The conversion of logs and the preparation of microscopic slides are well in hand.

(b) Considerable progress was made regarding the studies of the formation of growth rings in the wood of *Acacia catechu*, *Albizia lebbek*, *Bombar malabaricum*, *Cedrela toona*, *Dalbergia sissoo*, *Eugenia jambolana*, *Michelia champaca*, *Pinus longifolia*, *Shorea robusta*, *Swietenia mahayoni*, *Tectona grandis* and *Terminalia tomentosa*. About 118 fresh micro-blocks were taken from living trees and most of them were sectioned and studied. The Bengal and Madras forest departments, who are also interested in this investigation, have sent so far 60 and 63 micro-blocks respectively, from teak and mahogany trees. These specimens also are being cut and studied. The results of this investigation will be published shortly in two parts.

In *Terminalia tomentosa* the presence of an "initial" type of parenchyma was reported previously. During the year, further research regarding the origin, structure and distribution of this type of parenchyma was continued with a view to throwing further light on the subject.

(c) The anatomical study of the woods of the Indian Dipterocarps was much interrupted owing to the pressure of work from other more urgent enquiries and miscellaneous investigations.

(d) Little progress was made on the anatomical study of the woods of different varieties of *Terminalia tomentosa* for the same reason.

(e) A study of the relationship between the anatomical structure and the physical properties of teak (*Tectona grandis*) was taken up during the year. A new consignment of 107 specimens was received for examination. Each specimen has been cut longitudinally into two sticks for detailed microscopic examination as well as for

strength tests. In this connection, 428 blocks will have to be examined.

(f) The study on the woods of the Indian *Meliaceae* was continued.

(g) A detailed investigation on the anatomical and physiological effects of resin tapping in *Pinus longifolia* has been started. The Wood Technologist made a short tour to see the technique of resin tapping prevalent at Garkhet in Almora, and collected micro-blocks from tapped, acid treated, low yield and high yield trees. All the blocks have been cut and photographed. The comparative study of the various sections under the microscope is progressing.

## 2. IDENTIFICATION OF WOODS.

The services of the Section for the identification of woods were utilized as usual with advantage by railway officers, engineers, timber merchants, the Army Department, the Forest Department, jute mills, and various firms dealing with timbers in some form or another. The following are some of the more important and interesting investigations completed during the year:—

- (1) The North Western Railway received a supply of bottom boards from a firm, quite a number of which were suspected as being of some timber other than gurjun (*Dipterocarpus* sp.), which was the timber specified in the contract. Out of 781 boards under dispute, the railway accepted 99 as gurjun and from the remaining 682, groups of similar looking woods were made, and 76 specimens from these groups were sent to Dehra Dun for checking. Out of these 76 specimens only five proved to be gurjun. The remainder included no less than 21 different species.
- (2) In another case, the same railway purchased from another firm some eng (*Dipterocarpus tuberculatus*) bottom boards, and as a large number of them appeared doubtful, they sent 4 specimens, representing different groups, to Dehra Dun for identification. On examination, not one of them was found to be even a *Dipterocarpus* species.
- (3) The Factory Rationalization Committee, Army Headquarters, sent specimens of "dogwood" (obtained from the War Office in England) for examination, and wanted to know whether a similar wood grew in India, so that the committee might be helped in "investigating the

possibility of manufacturing in India certain fuse powders requiring the use of dogwood as a raw material for making charcoal". The samples of "dogwood" were identified as *Rhamnus* sp. From an anatomical point of view it was doubtful whether Indian *Rhamnus* species would serve the same purpose, so other possible Indian woods were suggested instead.

- (4) An Executive Engineer in Bihar received a supply of sal (*Shorea robusta*) and teak (*Tectona grandis*) under a contract, but before finally accepting the timber as such, he wisely sent specimens to Dehra Dun for the Wood Technologist's opinion. On examination they were found to be neither sal nor teak.
- (5) A Controller of Stores sent four samples of timber cut from a supply of bottom boards and asked for our opinion as to whether or not they were representative of the Burma gurjun known as *kanyin*. On examination, it was found that only two were correct according to the specification.

The total number of timbers identified as the result of enquiries during the year was about 320.

### 3. SPECIAL ENQUIRIES.

Some special investigations were as usual carried out on behalf of officers of the Forest and Railway Departments. Enquiries received under this head continue to increase and take up a great deal of time, as they are usually new problems with a variety of fresh factors involved. Some of the more important investigations are recorded below:—

- (1) *Sterculia urens*.—An investigation to determine the best method of tapping *Sterculia urens* (*karar*) for its gum, was started. A preliminary survey had to be made, to find out the nature and distribution of the gum ducts in the wood. In this connection both bark and wood had to be examined from tapped and untapped trees, and the results indicated the advisability of studying more blocks from living trees. A tentative programme has, therefore, been drawn up and the investigation will be continued. This enquiry was taken up on behalf of the Central Provinces and the United Provinces forest departments.

- (2) *Santalum album*.—The Chief Forest Officer, Coorg, sent 48 discs of sandalwood for examination, with a view to ascertaining whether the growth rings visible on the cross section indicated the correct age of the trees. The examination of the discs is almost complete, and the data are being analysed with a view to a note being issued on the subject.
- (3) *Shorea robusta*.—The Conservator of Forests, Bihar, sent sal poles to estimate the age by counting the rings, and incidentally also to ascertain, if possible, from the study of the wood structure, the effect of improved growth due to the trees being situated very near an irrigated area. As usual, the sal discs, on examination, showed irregular marks due to the presence of bands of gum ducts or of parenchyma cells, but neither of these structures could be traced as complete rings. The results obtained indicated that for some time to come, the possibility of finding out the age of sal trees by counting the so-called growth rings will have to remain an open question. Further, the comparative wood structure did not justify the conclusion that the wood produced from the irrigated areas was different from non-irrigated areas.
- (4) *Dipterocarpus macrocarpus*.—The Silviculturist, Shillong, Assam, sent a disc of hollong to find out the age of the tree by counting the growth marks on it. This specimen proved to be very interesting due to the presence of distinct growth rings. It may be noted here that usually growth rings are indistinct in hollong as well as in other species of *Dipterocarpus*. A report was sent indicating the age of the tree based on the ring counting.
- (5) *Michelia excelsa*, *Quercus lamellosa*, *Quercus lineata* and *Gmelina arborea*.—In response to an enquiry from the Central Silviculturist regarding the distinct visibility of growth rings in these species, various specimens of the Forest Research Institute collection were examined and following note was submitted:—*Michelia excelsa* shows distinct growth marks, but neither *Quercus lamellosa* nor *Quercus lineata* has prominent growth marks. In *Gmelina arborea*, growth rings are usually distinct and specimens from certain localities sometimes even show ring-porous characteristics.

- (6) *Aucoumea klaineana*.—The Officer in charge, Workshops, K. G. O., Bengal Sappers and Miners, Roorkee, sent a sample of wood from a folding boat for identification and to find out the cause of its failure. It was identified as *Aucoumea klaineana* which is sold in Europe under the trade name of Gaboon mahogany. Microscopic examination showed that the timber was badly attacked by fungus.

The total number of wood specimens examined in connection with special enquiries was 120 and about 450 specimens are still in hand.

#### 4. EXAMINATION FOR DETECTING FUNGUS ATTACK.

As usual enquirers sent for examination many wood samples suspected of having been attacked by fungus. The total number of wood specimens examined in this connection was 50.

#### 5. INDEXING PERMANENT SLIDES AND PHOTOMICROGRAPHS.

During the year under review, over 2,300 permanent slides of wood sections were prepared and added to the authentic collection. The slides were prepared both from Indian and foreign woods and quite a large number were prepared from species not previously represented. For publication and exhibition purposes, 33 negatives, 391 photomicrographs and 12 enlargements were made.

#### 6. COLLECTION OF AUTHENTIC WOOD SPECIMENS.

(a) *From India*.—As usual a good number of authentic wood specimens backed by herbarium material were received from the different provinces for research purpose and also for the Institute's standard collection.

(b) *From abroad*.—During the year altogether 284 wood specimens were added to the foreign collection. These were received from England, the United States of America, France, Brazil, Japan and Siam. To the donors our sincere thanks are due for helping the Forest Research Institute to make its collection of commercial timbers of the world as complete as possible.

#### 7. DISTRIBUTION OF WOOD SPECIMENS.

In response to requests from abroad and various parts of India, 778 wood specimens were supplied to enquirers. Quite a number of these specimens were sent to schools and colleges for instructional purposes.

### 8. TRAINING.

The following officers received instruction in the Wood Technology Section with a view to their acquiring some knowledge of wood anatomy and wood identification:—

1. Mr. P. A. Wanaraks, Siamese Forest Service.
2. Mr. A. Ghaffar, Student Sleeper Passing Officer, Bengal Nagpur Railway, Calcutta.
3. Mr. R. Krishnamurty, Mysore Forest Department.

### 9. TOUR.

Mr. K. A. Chowdhury went on tour to Ranikhet and Garkhet in connection with the anatomical and physiological investigation on the effect of resin tapping in chir (*Pinus longifolia*).

## Timber Testing Section.

### SPECIAL INVESTIGATIONS.

1. The study of the effect of corrosive chemicals on the strength of wood was continued during the year under review, but tests were done on only one species, namely deodar (*Cedrus deodara*). This work is being carried out in co-operation with the Seasoning Section which does the actual soaking tests.

2. A small log of locust (*Robinia pseudo-acacia*) received from the Director of Agriculture and Allied Departments, North-West Frontier Province, was tested in order to find the uses to which this species could be put. Although the material was not sufficient for full scale tests, it showed that the timber might be of considerable value if it was available in commercial quantities. It could be used as a substitute for imported ash and hickory for tool handles of all sorts. It was also found to be suitable for sports goods, delicate turnery and bent work.

3. Full scale tests were done on one consignment of *hoom* (*Sacopetalum tomentosum*) received from Kanara Eastern division, (Bombay), under Project 1. The tests show that it might be a very suitable species for the manufacture of bobbins, and it could be used as a substitute for imported birch and beech for other purposes also. It is, in addition, suitable for making bentwood furniture, light sports goods such as badminton rackets, foot rules, pen-holders, brush handles and a variety of small turnery articles. The timber should prove valuable to Bombay Presidency, as large

quantities of hohhins are required every year by the textile industry. It is a species worth cultivating in suitable localities.

4. Timbers used in aircraft construction, and samples obtained from wooden parts damaged in accidents, altogether amounting to 13 consignments, were tested during the year for the Director of Civil Aviation in India. It is now the general practice to use for the repairs of aircraft only such consignments of timbers as have passed the check tests at the Forest Research Institute. The soundness of this procedure has become evident from the fact that large quantities of imported aircraft spruce had to be rejected by one firm as the sample specimens sent to Dehra Dun revealed considerable weakness and fungal attack when tested. These aircraft check tests now done at Dehra Dun will undoubtedly help to increase the air worthiness of Indian aircraft.

5. Apart from the above tests, special efforts are being made by the Timber Testing Section to find suitable Indian woods for aircraft construction and repair work. Himalayan silver fir and spruce were chosen first for testing, and 8 selected sleepers of fir and 11 of spruce were specially obtained from Dhilwan in the Pnnjab for this work. All the samples had, however, to be rejected as the material was found to be attacked by fungus. As spruce and fir grow very high up in the inner Himalayas it takes a long time for the timber to reach its destination in the plains, and conditions throughout the journey are usually favourable for fungus attack. If some means could be found to hasten the transport of selected fir and spruce sleepers, they could probably supply the demand for all the smaller sizes required in aircraft work. This small material constitutes 70 per cent. of the total timber used in aircraft work. The investigation is being continued and other species are under trial, as the prices paid for aircraft timber are very attractive.

6. An unusually large number of glue joint test pieces were submitted during the year by candidates applying for ground engineers' licences. Failures among candidates from the Aeronautical Training Centre, Ltd., New Delhi, have been high. It is necessary for applicants to pay more attention to the requirements of the specification and to the proper method of making joints in order to avoid failure.

7. With a view to revising the present grading rules for teak squares, the Officer-in-Charge made two tours to Moghalpura, Lahore, and took observations on 431 teak squares from Burma purchased by the North Western Railway and passed under the

new grading rules. The preliminary calculations have already been done. A report is under preparation and is expected to be ready in a short time.

8. In order to increase the utilisation of timber in structures and to simplify the work of timber designing, the Officer in Charge prepared charts for the design of timber beams. From these charts, the proper sizes of timber beams for any given conditions of span and loading, and for any given species, can be readily obtained without any calculation, by simply following the lines on the charts with a pointer. Before they were printed, the charts were shown to the officers of the Royal Engineers at Roorkee, and their opinion on them was asked. Their report was very favourable, and they have already requested that they may be allowed to reproduce the charts in the Military Engineering Service Handbook.

9. As a result of an enquiry from the Madras Forest Department as to the strength properties of palmyra palm, tests were made to find out the suitability or otherwise of palmyra poles for electric transmission. Several 20-foot poles were tested by preparing a special testing platform on the 100,000 lbs. Riehle testing machine. A palmyra pole consists of a hard durable outer wall with a very soft perishable core. In this respect it differs from a tree which usually has a heartwood more durable than the sapwood. Palmyra poles are practically hollow circular tapering cylinders, but they proved to be equal in strength to sal poles of similar outside dimensions.

10. 107 scantlings of Burma teak of various rates of growth were received from the Forest Economist, Burma, for studying the relation of growth to strength. The tests have been completed. A detailed anatomical study of the differences in the structure of the specimens is now being made by the Wood Technologist, and if sufficient data are available a report will be prepared about the variations of strength and the reasons therefor.

11. Special tests for the study on "Moisture-strength relations" of Indian timbers were started during the year in co-operation with the Seasoning Section, and considerable progress was made. One consignment of sissoo (*Dalbergia sissoo*) has been tested completely and another of rosewood (*Dalbergia latifolia*) is nearly finished. Small specimens of the timber are seasoned to different moisture contents in specially constructed chambers, having accurate control of temperature and humidity, care being taken to bring them all to as uniform a condition as possible. They are

then tested in static bending, impact bending and compression, without allowing changes of moisture content to take place. Careful shrinkage observations are also made.

The work will be continued until a sufficient number of species have been tested, in order to find the true nature of the relation between moisture content and strength.

12. Special tests on deep beams were also started during the year, for determining the horizontal shear stress developed in bending, with a view to evaluating safe working stresses in horizontal shear for beams. Some differences of opinion have arisen among Indian engineers as to the value of the factor of safety for shear to be used in designing. The Timber Testing Section has so far adhered to its old custom of calculating the horizontal shear stress by applying a factor of safety of ten to the shear stress as obtained by tests on small clear specimens. This safety factor of ten is generally used in all laboratories where special tests on deep beams have not been made. Some engineers in India, however, considered that it was unnecessary to take such a high factor of safety, especially in view of the low factor of 7.7 recommended by the Forest Products Laboratory of Madison, United States of America, for a softwood species like southern yellow pine. As no data are available as yet in India, to defend either theory it was decided to make some special tests before introducing any change. Some tests have already been made on sal, and other tests in this connection are being undertaken as soon as timber is available.

13. As decided by the Utilisation Conference of March 1937, a study of the variation of the strength properties of sal (*Shorea robusta*) from important sal producing areas in India has been started. Some 10 or 12 consignments of sal from different localities are being obtained for this study. Tests on two consignments are already in progress.

14. A number of graphs were prepared for establishing relations between the different strength functions and the specific gravity of Indian timbers. Some interesting facts were obtained from this study. It has been noticed, for instance, that in bending, Indian species are slightly stronger in the green state than American species, although having approximately the same specific gravities, but the improvement in strength during seasoning is less than that for American species. The study is being continued and a publication will be issued in due course.

15. Some tests were made on tea chests submitted by the Assam Sawmills & Timber Co., Ltd., with a view to improving the exist-

ing design of these containers. The company appreciated the work and wrote as follows:—

“ $\frac{3}{14}$  inch thickness of panels was adopted as our standard as a result of your report and has given us every satisfaction since its adoption.”

#### ROUTINE TESTING.

During the year under review, tests were continued under Project 1 (Standard tests on small clear specimens), and Project 2 (Standard tests on structural timbers). Other routine tests such as glue adhesion, plywood, and tests of glue joints submitted by ground engineers for their licence examination, etc., were done as and when required.

#### NUMBER OF SPECIES TESTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1 . . .	9	14	17	...
Project No. 2 . . .	1	4	...	...
Project No. 0 . . .	Under all heads . . .			93

The 93 consignments under Project No. 0, includes 43 consignments of glue joint test pieces submitted by ground engineers for their licence examination, as against 15 in the previous year.

#### NUMBER OF SPECIES COMPUTED DURING THE YEAR.

	Green.	Air dry.	Kiln dry.	Miscellaneous.
Project No. 1 . . .	2	14	...	...
Project No. 2 . . .	...	...	...	...
Project No. 0 . . .	Under all heads . . .			61

#### List of Species tested under Project No. 1 during the year.

Species.	From	Condition.
<i>Albizia odoratissima</i> (black siris) .	Coimbatore, Madras . . .	Green and Kiln dry.
<i>Amoora rohituka</i> (amooru) . . .	Nowgong, Assam . . .	Air dry. (Second lot).
<i>Amoora scallickii</i> (amooru) . . .	Katha, Burma . . .	Ditto.
<i>Artocarpus integrifolia</i> (Jack)—Hill grown.	S. Mangalore, Madras . . .	Green and Kiln dry.
<i>Artocarpus integrifolia</i> (Jack)—Plain grown.	Ditto . . .	Ditto.
<i>Balanocarpus utilis</i> . . .	Tinnevely, Madras . . .	Ditto.
<i>Bacca distyrces</i> (hill mahua) .	S. Andaman . . .	Air dry.
<i>Corallia lucida</i> (Syn. <i>Corallia integririma</i> ) (maniswaga).	Nowgong, Assam . . .	Air dry.

## List of Species tested under Project No. 1 during the year—contd.

Species.	From	Condition.
<i>Chukrasia tabularis</i> (chickcrassy) .	Katha, Burma . . . .	Air dry.
<i>Dalbergia cultrata</i> (Burma black-wood).	Burma . . . .	Green and Kiln dry.
<i>Dichopris polyantha</i> (tali) (Syn. <i>Isonandra polyantha</i> ).	Cachar, Assam . . . .	Air dry.
<i>Engelhardtia spicata</i> (moglaipoma) .	Nitto . . . .	Kiln dry.
<i>Eugenia</i> sp. (jaman) . . . .	Nitto . . . .	Nitto.
<i>Grewia vestita</i> (siyalphura) . . . .	Kurseong, Bengal . . . .	Green and Kiln dry.
<i>Hardwickia pinnata</i> (piney) . . . .	Mangalore, Madras . . . .	Ditto.
<i>Heritiera</i> sp. (dhamin sundri) . . . .	Cachar, Assam . . . .	Air dry.
<i>Heterophragma roxburghii</i> . . . .	S. Chanda, C. P. . . .	Air dry and Kiln dry.
<i>Millettia pendula</i> (thinwin) . . . .	Burma . . . .	Green and Kiln dry.
<i>Mimusops littoralis</i> (bullet wood) .	South Andaman . . . .	Air dry.
<i>Pentace griffithii</i> (thital) . . . .	Tavoy, Burma . . . .	Air dry.
<i>Poeciloneuron indicum</i> . . . .	N. Mangalore, Madras . . . .	Kiln dry.
<i>Pongamia glabra</i> (saykaranji) . . . .	E. Kanara, Bombay . . . .	Air dry.
<i>Pterocarpus santalinus</i> (red sanders)	S. Cuddapah, Madras . . . .	Air dry and Kiln dry (2 cons.).
<i>Saccopetalum tomentosum</i> . . . .	E. Kanara, Bombay . . . .	Air dry.
<i>Stereospermum chelonoides</i> (padri wood).	S. Mangalore, Madras . . . .	Kiln dry.
<i>Terminalia myriocarpa</i> (hollock) .	Lakhimpur, Assam . . . .	Air dry.

## List of Species tested under Project No. 2.

Species.	From	Condition.
<i>Bassia latifolia</i> (mahua) . . . .	Jubbulpore, C. P. . . .	Air dry.
<i>Canarium strictum</i> (white dhup) .	Madras . . . .	Ditto.
<i>Machilus macrantha</i> (ladder wood) .	N. Mangalore, Madras . . . .	Ditto.
<i>Pentace griffithii</i> (thital) . . . .	Burma . . . .	Green.
<i>Pterospermum acerifolium</i> (hatti-palla).	Buxa, Bengal . . . .	Air dry.

About 15,000 mechanical tests and 20,000 physical determinations were made during the year. In addition to computing the routine tests, the computing office prepared a number of graphs and tables for the design of timber beams and for answering enquiries. Numerous computations for the revision of the existing grading rules for teak squares were also made.

## Wood Seasoning Section.

### 1. KILN DRYING RESEARCH WORK.

No fresh material for kiln drying experiments was received during the year, and whatever small stock of wood was in hand was reserved for special experiments in connection with the testing of the Furnace kiln. The kilns were therefore run on material received from the Wood Workshop and the Timber Testing Sections, and from some furniture makers in the town. The new metal-lined laboratory kiln was not found to be sufficiently air and moisture-proof, and certain experiments on kiln drying that had been planned had to be postponed till a second kiln on an improved design was constructed.

*Salt Seasoning.*—Experiments were carried out on *Terminalia tomentosa*, *Adina cordifolia*, *Albizzia procera* and *Bassia butyracea* to determine whether the soaking of freshly converted material of these species in a solution of common salt prior to kiln drying had any effect on the drying properties of the wood but so far none of these experiments have given any positive results.

### 2. FURNACE KILN.

Five charges of wood were dried in the Furnace kiln during the year, all of which gave very satisfactory results. One of the charges consisted of 2-inch thick planks of axlewood (*Anogeissus latifolia*), which was dried from a moisture content of 37 per cent. to 10 per cent. in 19 days. This is a very refractory wood, liable to severe surface cracking during seasoning, but in this kiln both the speed and the quality of drying were excellent, there being no appreciable damage from cracking, warping and other causes. Other woods dried in this kiln during the year were *Dalbergia sissoo*, *Dalbergia latifolia*, *Albizzia lebbek*, *Cedrela toona*, *Stereospermum chelonoides*, *Terminalia bialata* and *Terminalia tomentosa*. One inch thick planks of *Cedrela toona* were dried from an initial moisture content of 50 to 70 per cent. down to 10 per cent. moisture content in 9 days, without any collapse or any other degrade.

*Improvements to the kiln.*—In order to increase the humidity of air during the conditioning treatment at the end of a kiln run, a second water spray pipe was introduced in the kiln and a baffle plate was fitted to allow more intimate mixing of spray water with the hot furnace gases. This resulted in considerable improvement of the conditioning treatment, and it was found possible to

raise the relative humidity of the furnace gases to about 90 per cent. of saturation.

*Comparison with ordinary kiln drying.*—In the Furnace kiln it has been possible to employ higher temperatures and lower humidities than those found suitable for drying wood in an ordinary steam-heated kiln, with the result that the drying has been more rapid, without any apparent adverse effect on the quality of dried wood. In order to compare the drying of two charges of a wood, one dried with furnace gases and the other with air heated and humidified with steam, the Furnace kiln has been fitted with a steam heater and a steam spray pipe, so that any conditions of temperature and humidity can be maintained in the kiln. It is intended that one charge of one inch planks of sissoo (*Dalbergia sissoo*) will be dried in the kiln in the usual manner using furnace gases, and a second charge will be dried with hot air, the kiln being run on exactly the same wet and dry bulb conditions as before. The rate of drying of the two charges as well as the quality of dried material will be compared. The necessary alterations to the Furnace kiln are in progress.

*Indirect heated Furnace kiln.*—In the present Furnace kiln, hot combustion gases from the furnace come directly in contact with the wood to be dried, which results in a slight superficial discoloration of the dried wood. In order to overcome this defect, and also to simplify the construction and operation of a kiln of this type, it is intended to put up one or two kilns in which the furnace gases will circulate through sheet metal ducts to heat the air used for evaporating moisture from wood. Equipment for one kiln of this type is on order from Austria, and it is proposed to obtain in the coming year a ready built furnace from Germany for a second kiln of this type. There is a definite demand in this country for a very simple type of kiln, preferably requiring no steam and motive power, and costing not more than a thousand rupees to build. Efforts are being made to bring out a design which will meet these requirements.

### 3. COMMERCIAL INSTALLATIONS.

It is gratifying to report that considerable progress has been made during the year in the introduction of commercial kilns in the country. A firm in Calcutta, which started only two years ago with two small kilns, has now put up 4 more large sized kilns and these are being kept busy to their full capacity. A sawmill in Assam is putting up a battery of kilns with a drying capacity of 10 tons of sown material per day. Seasoning kilns are also

being put up at Hyderabad (Deccan), Shimoga (Mysore) and Madras. Designs for all these installations were drawn up and supplied by the Seasoning Section and the equipment is being made in the country. A plywood factory on the West Coast is constructing two tunnel driers for drying veneers according to design supplied by the Institute. A design for a furnace kiln was supplied to the Ceylon Forest Department, which, it is understood, is in course of construction, and a scheme for the alteration of one of the external blower kilns at the Gun Carriage Factory into an internal fan type of kiln was drawn up. This has been sanctioned by the authorities, and the alterations will be carried out during the coming year.

#### 4. AIR-SEASONING.

Very little material was stacked for air-seasoning during the year, as the stock of timbers for Project VII was practically exhausted. Final observations on the following timbers which were stacked in previous years were taken:—

- (1) *Altingia excelsa*—6" × 4" scantlings.
- (2) *Anogeissus latifolia*—4" × 4".
- (3) *Artocarpus chaplasha*—1½" planks.
- (4) *Eugenia gardneri*—10" × 5" and 3" × 3" scantlings.
- (5) *Gmelina arborea*—1" and 2" planks.
- (6) *Heritiera minor*—3" × 3" scantlings.
- (7) *Hopea odorata*—½", 1" and 2½" planks.
- (8) *Hopea parviflora*—6" × 4" scantlings.
- (9) *Hymenodictyon excelsum*—1" planks.
- (10) *Ougeinia dalbergioides*—1" and 2½" planks.
- (11) *Quercus lamellosa*—6" × 4" scantlings.
- (12) *Quercus lineata*—6" × 4" scantlings.
- (13) *Stereospermum chelonoides*—2½" × 2½".
- (14) *Terminalia bialata*—1" and 2" planks.

*Seasoning in scantling sizes.*—A number of species were seasoned in the form of thick scantlings, and it was found that except for *Altingia excelsa* all woods up to 6" × 4" had dried thoroughly in 2 years' stacking under cover, but the thicker material, e.g., 10" × 5" beams of *Eugenia gardneri*, was still wet in the interior and required further drying. *Quercus lamellosa* and *Q. lineata* suffered very heavy degrade on account of surface cracking, heart shakes, collapse, warping, twisting and crookedness, but it must

be noted that out of the seasoned scantlings it is possible to obtain some good planks on re-sawing, while green conversion into thin sizes would have led to almost entire rejection of the whole lot at the end of the seasoning process. For some of these highly refractory woods, air-seasoning in the form of scantlings and re-conversion into plank material is obviously the best solution.

*Closing up of cracks.*—Another observation, which is not a new one, is that during the early stages of seasoning the surface cracks on wood open out very badly giving one an impression that the wood is practically useless for any purpose. When, however, the process of seasoning is complete, these cracks close up and become almost invisible, giving quite a contrary impression about the quality of the wood. While taking moisture tests from some of the well dried scantlings of *Anogeissus latifolia*, *Hopea parviflora* and other woods, it was noticed that what appeared like hair cracks on the surface, penetrated to a depth of one inch or more.

*Girdling of deodar trees.*—Two trees of deodar were girdled in the Chakrata forest division in October 1935, and were felled in May 1937. Two ungirdled trees of deodar were also felled at the same time to serve as controls. All the four trees were converted into broad gauge sleepers, which were brought to Dehra Dun for observation. The experiment is in progress, but no indication has so far been found to show any advantage of girdling of standing trees of deodar before felling.

## 5. WATER-SOAKING PRIOR TO AIR-SEASONING.

The material that was included in this test, which was started 4 years ago, was found to be of such poor quality that no useful results would have been obtained by testing the strength properties of the soaked and unsoaked specimens. The whole lot was, therefore, taken out of the water and the experiment was postponed till better material was available.

## 6. AIR-SEASONING OF RAILWAY SLEEPERS.

*Seasoning experiment on chir sleepers.*—An experiment on the air-seasoning of chir sleepers in the East Almorah division of the United Provinces was started during the year in co-operation with the United Provinces Forest Department, The Indian Turpentine and Rosin Co., Ltd., and the Sleeper Control Officer, Northern Group. The experiment is planned to study the seasoning of chir sleepers from the time they are cut, right up to the time they are used, in order to obtain definite information on the amount

and nature of seasoning defects, and the rate of drying of sleepers at various stages of seasoning. It is expected that the information obtained from this investigation will enable us to suggest ways and means of improving the seasoning of chir sleepers, as well as of minimizing seasoning degrade, which is a cause of heavy rejections at the time of passing. The experiment was divided into two parts. Two thousand sleepers were selected in the forest for stacking in the winter months, October to January, and one thousand sleepers were taken under observation in the hot season, i.e., in the month of April. The experimental sleepers were stacked at the launching depôts in the close crih manner, the stacks having been covered with thatch. Before stacking, the sleepers were weighed, their condition noted, and a complete record, showing the position of each sleeper in the tree, the size of the tree, and the slope of the hill, etc., was made. The observations with regard to weight and the condition of the sleepers will be taken again, first at the time the sleepers are launched, and again when they arrive at Tanakpur and finally at the time of passing.

*Effect of tarring.*—As end-cracking is the most serious defect in chir sleepers, and as tarring the ends of sleepers in the forest has proved beneficial in the case of softwood sleepers extracted from Kulu and Seraj divisions in the Punjab, three thousand chir sleepers in the East Almora division were end-painted, half the number with thick coal tar and the other half with chir tar. The amount of end-cracking of these sleepers will be observed at the time of passing and compared with other sleepers from the same area which have not been given any end-coating.

*Log seasoning.*—As mentioned in the last year's report, the effect of seasoning in log form is also included in this investigation. Twenty trees of chir were felled in March 1937, and the logs were allowed to season in the forest. Sleepers obtained from these trees have been marked separately and their behaviour will be observed along with the other experimental sleepers.

*Sal sleepers.*—Reference is made in the last year's report to a seasoning experiment on meter gauge sal sleepers, started in co-operation with the Rohilkund and Kumaon Railway, near Lucknow. The stock of 500 sleepers under seasoning was examined, as also the sleepers laid last year in the line in green condition. It was observed that the sleepers stacked for seasoning showed a little more cracking than those in the line, which were covered heavily with ballast, but it is yet too early to pass any definite opinion on the investigation.

*Madras hardwood sleepers.*—During the course of a tour to Madras, the Officer in charge of the Section accompanied Mr. M. A. Hafiz, the Assistant Forest Utilization Officer, Madras, to see the passing of hardwood sleepers of teak, irul (*Xylia xylocarpa*), nangal (*Mesua ferrea*) and irumbogam (*Hopea parviflora*) for the South Indian Railway, in order to observe the defects to which each species is liable. It is proposed to start an experiment on the seasoning of hardwood sleepers on the West Coast of Madras, and a detailed scheme is being drawn up for the purpose.

#### 7. ELECTRIC MOISTURE METERS.

The variation of electrical resistance of wood with moisture content is being studied for some of the commercially important species of Indian woods. The results so far obtained indicate that Indian woods can be divided into two groups, one having a relatively higher resistance than the other. The study is still in progress.

Many enquiries were received for the electric moisture meters, and it is understood that five more meters were sold during the year by Messrs. R. Mukerjee & Co., who have been entrusted with their manufacture.

#### 8. WOODS FOR SHUTTLES.

An important investigation has been started to find out indigenous woods suitable for hand and power loom shuttles. The woods required for the purpose are naturally hard and refractory and their proper seasoning before use is imperative if good results are to be obtained. There are only two commercial concerns in the country engaged in the manufacture of shuttles, and the only wood used for the purpose is cornel wood imported from America. A large number of Indian woods have been tried, but all of them have been reported on as unsuitable, chiefly on account of the lack of proper seasoning before use and also for want of selection of material, which is very necessary, as the blocks for this work should be entirely free from cracks, shakes, splits, knots and other defects. It has now been arranged to obtain from various forest departments woods which are considered suitable for the purpose in the form of logs, which will be converted and seasoned at the Institute, cut into blocks of proper size, and the selected material free from defects sent for a manufacturing trial to the two shuttle factories who have expressed their willingness to co-operate in this investigation. Indian boxwood (*Buxus sempervirens*) and parrotia (*Parrotia jacquemontiana*) have been found suitable for

handloom shuttles and efforts are being made to arrange supplies of these woods from various sources. Blocks of kiln dried *Anogeissus latifolia* have already been sent to a firm in Bombay. *Ougeinia dalbergioides* is also under seasoning at present for this investigation and supplies of other woods are soon expected.

Similar investigations for specialized woodworking industries, such as tool handles, picking arms, jute mill rollers, shoe lasts and heels, etc., will be taken up in the coming year.

#### 9. WOODS FOR BATTERY SEPARATORS.

Numerous enquiries are being received on the subject of Indian woods considered suitable for battery separators. These are at present being imported from America, and are made of Port Orford cedar. An investigation has been started to find out which Indian woods can be used for this work. Battery separators will be made of various Indian woods and their life will be tested in actual use in a number of batteries which will be set up in the laboratory and alternately charged and discharged for a period of about one year.

#### 10. MOISTURE EQUILIBRIUM SURVEY.

This investigation was started in 1936, and the observations will be continued up to June 1938. A report on the investigation will be issued in the coming year.

#### 11. SHRINKAGE STUDIES.

As in the previous year, a large number of shrinkage specimens were kept under observation during the year. Detailed studies are being made of the shrinkage of wood from the green to the air dry condition, as well as the changes in the dimensions of seasoned wood due to fluctuations in atmospheric humidity. The following new species were taken up during the year:—

- (1) *Adina cordifolia*.
- (2) *Lagerstrœmia hypoleuca*.
- (3) *Albizzia procera*.
- (4) *Bucrus sempervirens*.

Shrinkage will be determined on small clear specimens as well as on plank material.

*Shrinkage retarding treatments*.—Tests on synthetic resins (Durez) received from America and also on the resins formed with furfuryl alcohol-furfuraldehyde mixture by the action of strong

mineral acids were started during the year. Small specimens of the following species were impregnated with resins and their shrinkage at various humidity conditions determined :—

- (1) *Adina cordifolia*.
- (2) *Bombax malabaricum*.
- (3) *Dalbergia sissoo*.
- (4) *Sterculia campanulata*.

## 12. END PAINTS.

End painting of small sleeper pieces of deodar was carried out with the following paints :—

- (1) Hardened gloss oil.
- (2) Paraffin-rosin mixture.
- (3) Coal tar.
- (4) Three special paints received from Germany.

The moisture-proofing quality of the above paints is also under investigation.

## 13. EFFECT OF CHEMICALS ON WOOD.

The work on the effect of various chemicals on wood described in last year's report was continued. Static bending tests have also been included in this investigation.

## 14. ENQUIRIES.

The number of enquiries received in this section is increasing yearly and over 130 enquiries were dealt with during this year. Designs of seasoning kilns were supplied to more than 25 enquirers.

## Wood Preservation Section.

This section functioned on a reduced scale during the year under review, owing to the transfer of the Officer-in-charge to the Timber Development Branch.

The following items of work were investigated during the period under review :—

### 1. OPEN TANK TREATMENT WITH ASCU.

An open tank method was worked out for treating certain types of wood efficiently with Ascu. The operation is carried out in two tanks—one containing plain water for heating the timber to be treated, and the other containing cold Aescu solution for use

after the wood has been heated in the water. This double tank method of treatment appears to give very good results in the case of small round sapwood timber such as fence posts. It is not applicable to square or sawn heartwood timber.

## 2. SERVICE LIFE OF TREATED AND UNTREATED TIMBERS.

(a) A new small demonstration test yard was prepared for showing to visitors the effectiveness of various methods of wood preservation and the efficiency or otherwise of different wood preservatives. Some 160 sapling hillets (2' 6" long) have been installed in it. They were treated with Ascu and creosote-crude oil mixtures using various methods of treatment.

(b) A few small tests, especially as regards splitting, were started on creosoted and Ascu treated shingles of various species of timbers by fixing them as a demonstration roof. Some treated shingles were also sent to the Andamans for test in a similar way.

(c) Some 21 ft. poles and some fence posts of chir pine (*Pinus longifolia*) and sal (*Shorea robusta*) were treated with Ascu and a creosote-fuel oil mixture and were installed in the new demonstration ground with a view to comparing the life of such poles treated with these two preservatives. Similar poles of some other species are at present undergoing seasoning and will be installed during the coming year.

## 3. FIRE-PROOFING TESTS.

Many fire-proofing chemicals and their mixtures have been tested from time to time at Dehra Dun, but most of them seem to have deficiencies or are very expensive. As a result of this research it is hoped that a cheap fire-retardant paint has now been evolved. Experiments are continuing to improve it still further.

## 4. GRAVE-YARD TESTS.

(a) The following proprietary boards and wood preservatives were put to test in the "grave-yard" for testing against termites and fungi:—

- (1) Heraklith boards (Ascu treated and untreated).
- (2) "Flexo" plywood.
- (3) "Tentest".
- (4) Asplund impregnated wall-board.
- (5) Wood fibre boards.

(6) " Porcella " paint.

(7) Magnesium oxychloride.

(b) Specimens of the following untreated species of timbers were also put under test in the test-yard:—

(1) *Engelhardtia spicata*.

(2) *Pentace griffithii*.

5. An official Forest Record on Ascu was prepared and sent to the Press. Taken as a whole the possibilities of Ascu continue to look promising. The preservative has now been under test for 5 years and the results are encouraging, but several years more must elapse before it can be accepted as efficient in all respects for use as a wood preservative in India.

#### 6. PENETRATION OF PRESERVATIVES INTO WOOD.

During the year under review, work on the movement of preservatives in wood, with special reference to various problems connected with Ascu and creosote, was started. A comparative study of the absorption of water, Ascu and dichromate by chir blocks (end penetration being avoided) showed that, under identical conditions, the blocks absorbed 77 per cent. of their weight of water, 26 per cent. of Ascu 4 per cent. solution, and 25 per cent. of 4 per cent. dichromate solution. The period of soaking was five weeks. When tested for compressive strength, there was no difference between the Ascu treated and water soaked pieces. Preliminary studies on the rate of flow of Ascu solution through transverse sections of chir showed that these sections are less permeable to Ascu than to water. The work is being continued. Other work to investigate the cause of the erratic permeability of chir to preservatives is also in progress.

Work on a further series of experiments on the mechanism of the fixation of Ascu in wood was also started during the year. The work in this connection is being continued, and the effect of soil salts, etc., on the leaching of Ascu is also being investigated.

#### Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other Sections, while the Officer-in-Charge devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 14,662 wood specimens for test purposes as detailed below:—

Static Bending—	
Research—1R . . . . .	145
1Spl. . . . .	40
Regular—1 . . . . .	1,477
Vehicle minor—1VM . . . . .	679
Plywood—1PW . . . . .	109
Impact Bending—	
Special—2Spl. . . . .	53
Regular—2 . . . . .	1,101
Royal Aircraft—2RA . . . . .	1,749
Compression Parallel—	
Structural—3Str. . . . .	48
Regular—3 . . . . .	2,636
Compression Perpendicular—	
Structural—4Str. . . . .	24
Regular—4 . . . . .	693
Hardness—5 . . . . .	707
Shearing—	
Regular—6 . . . . .	2,408
Plywood—6PW . . . . .	446
Glue Joints—6JB . . . . .	120
Tension Perpendicular to grain—7 . . . . .	680
Torsion—8 . . . . .	513
Shrinkage Radial and Tangential—9 . . . . .	548
Shrinkage Volumetric—10 . . . . .	214
Hammer Handles—1H . . . . .	33
2H . . . . .	34
Aircraft—1A . . . . .	173
Boxes . . . . .	32

The Wood Technology Section was supplied with 91 “Gamble” specimens, 1,075 hand specimens and 6 cubes for specific gravity tests.

In addition to supplying other Sections with converted material for research purposes, this Section completed 361 jobs of a varied character.

Reports on the working qualities of the undermentioned timbers were recorded during the period under review:—

*Myristica* spp.

*Heterophragma roxburghii*.

*Isonandra* spp.

*Carallia integerrima*.

*Sageræa laurina*.

*Heritiera* spp.

*Pongamia glabra*.

*Pentace griffithii*.

*Terminalia myriocarpa*.

*Saccopetalum tomentosum*.

### ENQUIRIES.

Various enquiries in connection with wood working and related subjects (other than veneers, plywood and glues) were received and dealt with.

### TESTS.

Tests were carried out on "Corroid" Mastic Composition for laying parquet floor blocks with a view to ascertaining its suitability under the climatic conditions prevailing in India. The blocks are still under observation.

Tests on the working qualities of *Robinia pseudoacacia* were carried out on behalf of the Director of Agriculture, North-West Frontier Province, and the results reported.

An experimental floor (using casein cement of our own formula) was laid during the year and is under observation. So far it does not appear to be so satisfactory as some other parquet floors laid with bitumastics.

Project VIII tests were carried out on a log of *Dalbergia sissoo* on behalf of the Divisional Forest Officer, Peshawar Forest division, and the results were reported.

### TRAINING.

Courses of training in Saw-doctoring were given to 6 selected soldiers from the King George V's Own Bengal Sappers and Miners, Roorkee, during the year under report.

### VENEER SUB-SECTION.

The officer in charge was on long leave from 25th March 1937 to 9th November 1937. On his return from leave, logs of the following species were peeled for test under Project VIII:—

*Pinus longifolia*.

*Boswellia serrata*.

*Cedrus deodara*.

A great many enquiries relating to veneers, plywood and glues were received and dealt with during the year. This subject appears to have attracted considerable attention recently, but the starting of plywood factories in India is greatly handicapped by insufficient supplies of suitable woods in most districts. At the same time, it is satisfactory to be able to record that one new plywood factory in Madras started production during the year, and there are signs that other factories will be inaugurated during the coming year.

Considerable interest has also been shown in veneers and laminboard production, and it is hoped that before long the manufacture of these two wood products in India will be an accomplished fact.

### **Minor Forest Products Section.**

The work of this Section has been reduced to answering enquiries and to carrying out the necessary routine work of the Section.

#### **1. F. R. I. PORTABLE CHARCOAL KILN ("FRIKILN").**

There has been a large demand for the scale drawings of this kiln from Divisional Forest Officers and charcoal contractors in various Provinces and States in India and also from foreign countries.

Replies to an enquiry made from all those who were supplied with the scale drawings of the kiln elicited the fact that more than 25 kilns are now working in various parts of India, and that the cost thereof ranged from Rs. 290 to Rs. 525. All users reported that the kilns were working satisfactorily.

#### **2. CHARCOAL BRIQUETTING.**

A note embodying the results of the experiments on charcoal briquetting with different binders was published in the "*Indian Forester*" of February 1937.

#### **3. CULTIVATION OF MEDICINAL PLANTS.**

The following drugs and herbs were grown successfully in the Minor Forest Product garden:—

*Asparagus adscendens*, *Asparagus gracilis*, *Ala vera*, *Acorus calamus*, *Ancilema scapiflorum*, *Curculigo orchioides*,

*Datura metel*, *Plantago lanceolata*, *Thalictrum foliolosum*, *Urginea indica*, *Vernonia anthelmintica* and *Withania somnifera*.

The following plants, namely,—

*Anthemis nobilis*, *Atropa belladonna*, *Bryonia alba*, *Digitalis purpurea*, *Digitalis lutea*, *Digitalis ambigua*, and *Saponaria officinalis*

were grown from seeds received from foreign countries supplied through the Forest Botanist. Germination was good and the plants are all growing well up to the time of report.

#### 4. KARAYA GUM (*Sterculia urens*).

Information on the method of tapping, uses, markets and prices was supplied to Provincial Forest Departments and various private firms.

#### 5. PRODUCER GAS FROM WOOD AND CHARCOAL.

There has been a number of enquiries on this subject and such information as was available was supplied to all enquirers.

#### 6. VISIT.

Col. R. N. Chopra, I.M.S., of the School of Tropical Medicine and Hygiene, Calcutta, and Mr. S. N. Bal, Curator, Industrial Section of Indian Museum, Calcutta, paid a visit to the Institute during the year, and were specially interested in the Minor Forest Products garden and the work on drug cultivation going on.

The senior students of the Ayurvedic College, Gurukul Kangri University, also paid a visit to the Institute during the year to see the Minor Forest Products garden and to obtain information as to the different medicinal plants of their own districts.

### Paper Pulp Section.

#### I. EXPERIMENTAL FACTORY.

1. Experiments on *Saccharum munja* (munj grass), sent by the Radhasoami Satsang Sabha, Dayalbagh, Agra, were completed. Satisfactory qualities of writing and printing papers were prepared from the grass. It appears from the results of the experiments carried out that this grass can be utilised for the manufacture of paper on a large scale, provided it is available at a cheap price.

2. Experiments on *Cymbopogon coloratus* (botha grass), sent by the District Forest Officer, South Cudapah, were completed. The large scale tests confirmed the previous laboratory results, viz., that the fibre of the grass was very short, that the bleached pulp obtained from it was not very clean and that papers, of cheap qualities only, could be produced from it in admixture with some long fibred pulp, such as bamboo pulp.

3. Experiments were carried out on the production of kraft paper from *Dendrocalamus strictus* (salia bamboo) from Orissa. The paper produced lacked strength, due primarily to the Institute not having suitable beating equipment for kraft and to insufficiently heavy press rolls on the small experimental paper machine.

4. Experiments were made on the production of mechanical pulp from (1) *Broussonetia papyrifera* (paper mulberry), (2) *Pinus longifolia* (chir) and (3) *Picea morinda* (spruce), and the various factors affecting the grinding of wood were studied. The pulp produced was short fibred and brown in colour, and the papers prepared from the three kinds of pulps were rather poor in quality. A more intensive study of the grinding process, with special reference to the preparation of mechanical pulp from various Indian woods, has been started.

5. The erection of the new digester was completed. When work was started, the circulation of the liquor from the bottom upwards was found to be unsatisfactory. Steps have been taken to rectify the defect.

6. Rai Bahadur H. N. Batham, retired Agricultural Chemist, United Provinces Government, was accorded special permission by the President to investigate the possibility of preparing pine wool (a packing material) from chir needles. As the experiments were started too late in the year, pine needles of satisfactory quality could not be collected. In addition, mainly due to defective machinery, the experiments were not satisfactory. Mr. Batham hopes to start another series of experiments on a larger scale next year.

7. About two tons of writing, printing, type and packing papers and mounting and drying boards and about 7 cwts. of newsprint papers were produced during the year on the experimental paper machine. About  $3\frac{1}{2}$  tons of papers, boards and pulp were supplied to the various offices of the Forest Research Institute and College, the Government of India Press, Provincial Silviculturists, the Archæological Chemist to the Government of India, and other officers.

## II. LABORATORY.

1. The following grasses were tested as to their suitability for paper making:—

- (a) Five samples of *Saccharum arundinaceum* and *Saccharum spontaneum* from Sind. The stems of *S. arundinaceum* gave a satisfactory yield, whereas the yields from the leaf-stalks of *S. arundinaceum* and *S. spontaneum* and from the stems of *S. spontaneum* were poor. As the leaf-stalks and stems of the two species were sent separately, the yields from the whole culms of the grasses could not be arrived at and no definite conclusions could be drawn.
- (b) *Karar* grass from Benares. The bleached yield from this grass was poor and the consumption of chemicals rather high. The grass, therefore, was not considered suitable for the manufacture of paper.
- (c) *Andropogon contortus* from Rewa State. The consumption of chemicals, yield of pulp and the fibre length indicate that the grass is suitable for the production of pulp and paper.
- (d) Four samples of *Anthistiria gigantea* (ulla grass) from Mailani range, United Provinces. The samples were obtained from four different areas, viz., (1) highlands, fire-protected, (2) lowlands, fire protected, (3) highlands, non-fire protected and (4) lowlands, non-fire protected.

The samples from highlands gave higher yields of pulps than those from lowlands, but the difference in yields from samples from fire-protected and non-fire-protected areas was only slight. In the case of samples from lowlands, the non-fire protected sample gave higher yield than the fire-protected sample. As definite conclusions could not be arrived at from the experiments, it is being arranged to carry out large scale tests on this grass in the Paper Mills at Lucknow. A consignment of the grass from the areas from where it can be exploited on a large scale has been supplied to the Lucknow Paper Mills.

2. *Production of kraft paper.*—A series of experiments were carried out to determine the optimum conditions for the production of kraft papers from (a) *Dendrocalamus longispatus* and (b) *Pinus longifolia* (chir pine). The maximum breaking length, which could be attained for the sample sheets was slightly over 10,000 meters in the case of bamboo, and 9,000 meters in the case of chir.

The minimum breaking length in the case of chir papers was slightly over 4,000 meters. The tear and burst factors in the case of both bamboo and chir papers compared favourably with those of the corresponding imported kraft papers. The experiments show that under favourable conditions of treatment, satisfactory qualities of kraft papers can be prepared from bamboos and chir.

3. The following two materials were tested and found unsuitable for paper making, due mainly to shortness of fibre-length:—

(a) Cashew nut wood from Cochin and (b) Arrow-root stems, green and dry, from Darjeeling.

4. The investigation into the causes of the discolouration of pulps has been held in abeyance for some time, pending the appointment of a chemist.

5. Routine analytical tests in connection with the softening of the boiler feed water were carried out, as and when required.

### III. INVESTIGATIONS ON BAGASSE ON BEHALF OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

The defibrator, hand-moulds and the dryer press were erected, and experiments on the production of insulation and wall boards were started towards the end of the year under report. A brief account of the work done and samples of the boards prepared were submitted to the meeting of the Sugar Committee of the Advisory Board of the Imperial Council of Agricultural Research held in Delhi on the 7th March 1938. The sound and heat insulation properties of the boards will be tested as soon as the apparatus, which has recently been obtained, is fixed up.

### IV. TOURS.

1. At the request of Messrs. The Mysore Paper Mills Co., Ltd., Mr. Bhargava visited Bangalore and Bhadravati in September 1937 to discuss certain matters connected with the erection of the mills at Bhadravati.

2. The services of Mr. Bhargava were placed at the disposal of the Cochin and Travancore Governments for a period of about 5 weeks in September-October 1937 to investigate the possibilities of manufacturing pulp and paper in those States.

3. In December 1937 Mr. Bhargava advised Messrs. The Upper India Couper Paper Mills, Lucknow, regarding some new machinery for the mill and the layout of the projected extensions.

## V. TRAINING OF APPRENTICES.

1. Dr. H. S. Sharma of the Mysore Paper Mills Co., Ltd., worked in the section from 15th April 1937 to the 13th July 1937.

2. The two Siamese students, Nai Sawai Supayasermesri and Nai Pairojna Dharmatcha, completed their course of training on the 15th July 1937.

3. Three apprentices of the Mysore Paper Mills Co., Ltd., (1) Mr. N. S. Narayana Setty, (2) Mr. A. Krishnamurthy and (3) Mr. D. Venkataramiah, attended the course of training from the 1st July to the 1st November 1937.

4. Mr. D. P. Bhargava of the India Paper Pulp Co. attended the course of training from the 2nd August to the 20th November 1937.

5. Mr. Vidya Bhusan Rastogi of the Rohtas Industries, Ltd., attended the course of training from the 1st September 1937 to the 31st January 1938.

6. Mr. Krishnamurthy was deputed by the Punalur Paper Mills Co., Ltd., for four months' training from the 21st January 1938.

7. Mr. S. S. Bhasin was deputed by Messrs. The Deccan Paper Mills Co., Ltd., for four months' training from the 25th January 1938.

## VI. GRANTS.

The Paper Makers' Association, Messrs. The Upper India Couper Paper Mills Co., Ltd., and Messrs. The Mysore Paper Mills Co., Ltd., contributed during the year Rs. 3,250, Rs. 250 and Rs. 500 respectively towards the paper pulp research expenses at the Institute.

## Mechanical Sub-Section.

Most of the machines of the Wood Workshops and the Veneer shop, including the A. C. & D. C. electric motors were repaired and thoroughly overhauled during the year.

The electric wiring of the 75 H.P. motor in the saw-mill and some other electric motors was renewed.

The Disintegrating Machine, together with the electric motors and starter, was erected in the Paper Pulp Section.

The new digester, with a pump and a 10 H.P. electric motor, steam and water pipe lines, was also erected in the same section.

New apparatus for preparing distilled water was erected, and several alterations and improvements were made to the wood pulp

grinding machine in order to improve the screening and application of load.

A new precision lathe for fine work was erected in the Iron Workshops.

The Ford and Chevrolet buses were overhauled during the year, and a new battery ignition system was fitted to the Fiat lorry.

The electric wiring for the new sound absorption test apparatus was completed. In addition to the above special work, all the electric motors, A. C. & D. C. generator sets, main switch boards, switchgears, electric wiring installations, Government lawn mowers, fire extinguishers and fire hydrants, light railway lines and trucks, etc., were maintained in proper order throughout the year.

## CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report:—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs—

- (i) *Vitex peduncularis*, Wall.
- (ii) *Beilschmedia Brandisii*, Hook.
- (iii) *Senecio chrysanthemoides*, DC.
- (iv) Fish poison plants.

B.—Oils and Fats—

- (i) *Actinodaphne angustifolia*, Nees.
- (ii) *Litsea citrata*, Bl.
- (iii) *Bauhinia variegata*, Linn.
- (iv) *Solanum indicum*, Linn.
- (v) *Ximenia americana*, Linn.

2. Forest soils.

3. Miscellaneous enquiries.

1-A. *Drugs*.

(i) *Vitex peduncularis*, Wall.—Preliminary examination of the leaves obtained from Samta range (Bihar) showed, as was reported last year, the presence of an amorphous glucoside and traces of a basic substance of the nature of an alkaloid. Further samples of the leaves (obtained from the Forest Utilization Officer, Assam; and Southern Range Officer, Sihsagar division) were examined and these gave a small quantity of an amorphous glucoside, some amorphous acids, a neutral substance m.p. 112°-113° C., a light yellow crystalline substance m.p. 262°-263° C. and traces of an alkaloid.

The yellow crystalline substance m.p. 262°-263° C. is fairly soluble in water, but sparingly so in rectified spirit and insoluble in other common organic solvents. It appears to resemble vitexin which has previously been isolated as the hydrolytic product of the glucoside of *Vitex litoralis* (Perkin, J. C. S., 1898, 1019) and of *Saponaria officinalis* (Barger, J. C. S., 1906, 1210). In the case of *V. peduncularis* it has not been possible to isolate the parent glucoside and it appears that vitexin is present in a free

state, since it is obtained from the aqueous extract of the alcoholic extract of the leaves, without any acid or alkali treatment.

In collaboration with the School of Tropical Medicine, Calcutta, its pharmacological properties are being investigated and till the results are ready it would be difficult to say if vitexin is the active principle of *V. peduncularis* and is responsible for the curative value of the plant in black water fever. In any case, no other constituent has yet been isolated which may appear responsible for the above virtues. The quantity of vitexin that is isolated is very small.

(ii) *Beilschmedia brandisii*, Hook.—This drug from Assam has a local reputation and use in chest complaints. Preliminary examination of the powdered air-dried bark, with 13 per cent. of moisture, gave the following amounts of extracts on being successively treated with solvents:—petroleum ether 0.75; sulphuric ether 0.45; chloroform 0.1 and alcohol 11 per cent. Of these, only the ether extract has given a small quantity of a crystalline material, which is being examined further. A small quantity (0.015 per cent.) of an amorphous alkaloidal substance is also present.

(iii) *Senecio chrysanthemoides*, DC.—In a previous report presence of two alkaloids in senecio from Kashmir was reported. Identity of the alkaloid m.p. 120° C. is still obscure but the other melting at 223°-224° C. was shown to be identical with Jacobine isolated by Manske from *Senecio jacobea*. Doubts have been thrown on the purity of the material investigated by Manske and according to Barger and Blackie (J. C. S., 1937, 554) Jacobine from *S. jacobea* is a mixture of two alkaloids Jacobine m.p. 212° C. and Jacodine m.p. 217° C. The work on these alkaloids is in progress.

Some other workers have reported the variation of alkaloidal content in *Senecio* sp. with season, but the following results show that such is not the case with the Indian species; July, August and September collections all giving 0.27 per cent. of crude alkaloids.

(iv) *Fish poison plants*.—During the year, the exploratory work on fish poison plants has been carried on. The object of this investigation is mainly to discover such indigenous plants that possess the toxic constituents namely rotenone and allied bodies, which are found in derris, lonchocarpus and cubé of trade; and to determine how far India can be a source of supply of vegetable insecticides of the type of derris for which there is a demand and a valuable trade. Bearing in mind the fact that trade is always conservative and is unlikely to accept plant materials that do not

contain rotenone, attention is being directed to those plants only that contain these products. The investigation of fish poison plants that might happen to contain potent insecticides other than rotenone and allied bodies will be taken up later.

For the above exploratory work, a list of Indian plants reputed as fish poison has been compiled.

Since all the plants that have hitherto yielded rotenone belong to the Natural Order Leguminosæ, in our exploratory work attention is being concentrated on this natural order. A preliminary examination of the following has been carried out during the year:—*Cleisanthes collinus* (bark), *Albizzia procera* (bark), *Acacia pennata* (bark), *Pongamia glabra* (roots), *Pithecolobium bigenonium* (seeds), *Randia dumetorum* (seeds and pulp), *Mimosa himalayana* (bark), *Entada scandens* (seed husk) and *Tephrosia* sp. root-bark, leaves and seeds. All of the above plants have given varying amounts of ether solubles but none of them, except *Tephrosia candida*, gave any rotenone.

It is a matter of satisfaction to report the occurrence of rotenone in *Tephrosia candida*, DC. Following the usual method of extraction it has been possible to isolate 0.35 per cent. of rotenone from the root-bark and 0.5 per cent. from the seeds. The leaves also contain rotenone or allied bodies, as indicated by the usual colour reaction, but it has not been possible to isolate rotenone from them, in a pure state. The root-bark extract of *T. purpurea* also has given positive colour test for rotenone but the amount present is small, perhaps less than 0.3 per cent.

Some of the foreign species, *Caracca* (*Tephrosia*), *virginiana* of United States of America (*Scientific American*, 1933, 231) and the East African *T. macropoda* have been reported to contain rotenone and have been declared to be of value as insecticides. Indian *Tephrosias* occur in great abundance in some of our forests and the fact that such plants growing wild and of uncertain age have yielded 0.3-0.5 per cent. rotenone, is a matter of considerable importance and economic value, since it might be possible to improve the toxic constituents by care and cultivation.

Rotenone, along with the fatty oil, is extracted from *Tephrosia* seeds with sulphuric ether and from the ether free residue rotenone and resins are thrown off as precipitate by repeated washings with cold petroleum ether. These are then worked up in the usual manner. It appears that rotenone is concentrated in the root-bark and seeds and is practically absent in the stem or debarked root which explains our failure to isolate it on previous occasions.

(Ann. Rep., 1934-35). Systematic investigation of *Tephrosia*, *Milletia* and *Derris* sp. found wild in our forests is being planned. The richest samples, hitherto examined, of wild *Derris* or *Milletia* contained only about 2.5 per cent. of rotenone and 5 per cent. of total ether solubles. Judging from the prevailing standards for commercial *Derris*, that is 5 per cent. of rotenone and 16 per cent. or more of ether solubles, Indian species would appear to be very poor. These are of lower quality, no doubt, but even as such they have a place of their own. The low rotenone and resin content does not really take away much of its merits as an insecticide because the root powder has, after all, to be diluted with a considerable quantity of an inert substance like clay, in dusting preparations, in which 0.75 per cent. rotenone is considered sufficient. In derris dust preparations with a low grade *Derris*, the amount of inert diluent will be lower and consequently the concentration of the active *Derris* root particles will be higher. In this respect low rotenone content of the derris root turns out to be a matter of distinct advantage.

#### 1-B. Oils and Fats.

The investigation on the indigenous sources of lauric acid, as reported previously, has now been extended to *Actinodaphne angustifolia* and *Litsæa citrata*, and both of these fats are described below:—

(i) *Actinodaphne angustifolia*, Nees Syn., *Litsæa angustifolia*, Kurz, is an evergreen tree found in Assam, the Khasia Hills, Sylhet and Chittagong. Its berries yield 67 per cent. of kernels which contain 55 per cent. of a crystalline fat of the following constants:—

Melting point . . . . .	42°-45° C.
Optical rotation $(\alpha)_D^{25}$ . . . . .	-2.1°
Specific gravity @ 35° C. . . . .	0.922
Refractive index @ 40° C. . . . .	1.4453
Iodine value (Hanus) . . . . .	13.6
Saponification value . . . . .	266.6
Acid value . . . . .	7.9

The fat contains approximately 90 per cent. of trilaurin.

(ii) *Litsæa citrata*, Bl, is a very aromatic deciduous tree found in the Eastern Himalayas and the Khasi Hills. Its berries (sample from the Upper Tondou range, Bengal) yield 4.3 per cent. of an essential oil having a strong characteristic odour of lemon oil. This oil appears to be the same as that examined by Gardies (La Parfumerie Moderne, 1923, 107). The seeds yield 40 per cent.

of kernels which contain 54 per cent. of a crystalline fat of the following characteristics:—

Melting point . . . . .	40°-42° C.
Optical rotation ( $\alpha$ ) <sub>D</sub> <sup>25°</sup> . . . . .	-0.9°
Specific gravity @ 35° C. . . . .	0.911
Refractive index @ 40° C. . . . .	1.4404
Iodine value (Hanus) . . . . .	5.9
Saponification value . . . . .	269.5
Acid value . . . . .	0.55

The fat contains approximately 95 per cent. of trilaurin.

(iii) *Bauhinia variegata*, Linn.—The oil from the seeds of an allied species *B. esculenta* is reported to be non-drying, edible and medicinal. The investigation of the oil from *B. variegata* was taken up hoping that this might also be of the nature of the above oil. *B. variegata* is a large deciduous tree found commonly in the Dun and Saharanpur Siwaliks. The kernels yield 16 per cent. of a pale yellow oil of the following physical and chemical constants:—

Specific gravity @ 30° C. . . . .	0.9206
Refractive index @ 30° C. . . . .	1.4603
Iodine value (Hanus) . . . . .	91.3
Saponification value . . . . .	211.4
Acid value . . . . .	2.8
Unsaponifiable matter . . . . .	11.7%

#### Mixed acids.

Iodine value (Hanus) . . . . .	52.7
Mean molecular weight . . . . .	294.0
Saturated acids . . . . .	32.3%
Unsaturated acids . . . . .	67.7%

Further work on the isolation and identification of the constituent acids is in progress.

(iv) *Solanum indicum*, Linn.—This is a much branched under-shrub found commonly on waste lands in Dehra Dun and Saharanpur Districts. The berries yield 65 per cent. of seeds containing 10 per cent. of a yellow semi-drying, medicinal oil possessing the following constants:—

Optical rotation ( $\alpha$ ) <sub>D</sub> <sup>25°</sup> . . . . .	+0.5
Specific gravity @ 15.5° C. . . . .	0.9156
Refractive index @ 15.5° C. . . . .	1.4671
Iodine value (Hanus) . . . . .	121.5
Saponification value . . . . .	177.6
Acid value . . . . .	17.8

On standing the oil deposits a small amount of a white crystalline non-nitrogenous solid which when crystallised from alcohol melts at 242°-243° C. Further work on this substance and the constituent acids of the oil is in progress.

(v) *Ximenia americana*, Linn.—It was reported last year that the oil contained an unsaturated acid which was named ximenic acid. It was also reported that this acid is not described previously to be present in vegetable oils and fats. Its relationship to cerotic acid found in the mixed acids of the oil was established. Further work has shown that the unsaturation occurs in 20-21 carbon atom. Proof of this was obtained from its products on acetone-permanganate oxidation, which were shown to be caproic acid and a twenty carbon atom dicarboxylic acid. The fact that this dicarboxylic acid is not identical with the normal 20 carbon atom dicarboxylic acid which had been prepared synthetically by previous workers led to a more careful examination of the original cerotic acid and it was found that this inactive acid could be resolved into its optically active components. This indicated that the cerotic acid must be a racemic mixture of "branched chain" acids and not a normal acid. The above inference, it might be mentioned, is supported by the fact that the melting point (83°-84° C.) of the cerotic acid from the oil is appreciably lower than what has been reported (88°-89° C.) for the synthetic normal acid and also by the statement [Jamieson, "Vegetable Fats and Oils" (1932) 293] that only the "branched chain" acid appears to occur in nature. The work on the constitution of cerotic acid also indicates that ximenic acid with which it is related is not a normal chain acid but a branched chain one, with an optically active carbon in the molecule. Details of the work on ximenic acid is interesting and will be described elsewhere.

## 2. Forest Soils.

On recommendations of the Silvicultural Conference, a soil chemist (Dr. R. S. Gupta) has been appointed. Since his appointment Dr. Gupta has been touring in sal (*Shorea robusta*) areas in Dehra Dun division and familiarising himself with the forest soils in general, and sal soils in particular. He has also been studying the changes brought about in soils when they pass from agriculture to forest conditions. An interim report on this investigation will be presented next year.

A large number of soils received from various forest officers were also examined during the year.

### 3. *Miscellaneous Enquiries.*

A large number of analyses were undertaken on behalf of forest officers, officers of the Institute and other departments of the Government and of these mention may be made of the following:—*Artemisias*; *Ephedras*; *Derris*; *Aquilaria agallocha*, *Prunus* sp., etc.

## CHAPTER VII.—TIMBER DEVELOPMENT BRANCH.

During the year the Timber Development Section was placed in charge of a separate officer and made into a separate Branch of the Institute:—

The Timber Development Officer undertook the writing of short popular propaganda booklets on the following subjects:—

Treated wood for earthquake-resistant structures.

Special factors affecting timber design.

How to build wooden earthquake and storm-proof houses.

Treated timber bridges for Indian highways and railways.

Wood *versus* steel for framed buildings.

How to build fire-resistant timber structures.

Fire-proofing of wood.

Treated wood for roof trusses.

Treated wood for floors.

Treated wood for walls and ceilings.

These booklets were printed and released during the year under review. Over 16,000 were distributed free to the general public, businessmen and Government departments in India and abroad. These booklets raised considerable interest amongst various communities.

He also drew up designs and specifications for wooden bridges, 50-70 ft. span, roof trusses; a portable prefabricated hut and a watch tower—the last named at the request of the Chief Conservator of Forests, United Provinces, for use as a look-out for fire watchers in the forests. As a further aid to the popularisation of the use of treated wood, models of various types of bridges and trusses have been prepared. These models will be available for demonstration purposes and exhibitions.

The ban on treated wooden poles for carrying electric transmission lines having been lifted, large numbers of these poles have in the past few years gone into use for these purposes. In Northern India, one of the most suitable species for these purposes is chir (*Pinus longifolia*), considerable supplies of which are available in the Kumaon Hills. The Forest Department is, however, experiencing great difficulty in extracting these poles of the length required—40 ft.—owing to the sharp bends on these hill roads. To overcome this difficulty, attempts are being made by the Timber Development

Branch to evolve an efficient and at the same time sufficiently inexpensive type of joint, so that the poles can be extracted in lengths not exceeding 20 ft. A number of different types of joint have been tried out but while efficient enough, the cost is prohibitive and the appearance unsightly. Further experiments are being carried out to overcome these two defects.

Other species likely to be suitable for carrying electric transmission lines are being secured and will be given similar treatment and tested in the same way in the coming year.

The Timber Development Officer undertook an extensive tour, which included the more important industrial centres of Bombay, Madras, Calcutta and Delhi, and interviewed a large number of business men, engineers and others likely to be interested in the development of the uses of wood and particularly of treated woods.

## APPENDIX I.

*Publications of 1937-38.*

Serial No.	Title of Publication.	Author.	Date of issue.
1	The formation of Heartwood and its amount in Deodar Timber.	M. A. Kakazai	December 1937.
2	Entomological Investigation on the Spike Disease of Sandal (32) Lygaeidae (Hemipt.).	N. C. Chatterjee	October 1937.
3	Cis Latr. et. Anoblides nouveaux des Indes . . .	M. Pic . . .	October 1937.
4	Immature Stages of Indian Coleoptera (22) . . .	J. C. M. Gardner	October 1937.
5	New Crossotarsus (Platypodidae Col.) . . .	C. F. C. Beeson	December 1937.
6	Seed Weights. Plant per cents., etc., for forest plants in India.	J. N. Sen Gupta	July 1937.
7	Illustrations of Indian Forest Plants, Part IV . .	C. E. Parkinson	July 1937.
8	Entomological Investigations on the Spike Disease of Sandal (31) Dermaptera & Orthoptera.	L. Chopard & N. C. Chatterjee.	July 1937.
9	Second Interim Report on Work under Project VIII (Testing of Indian Timbers for Veneer and Plywood).	W. Nagle . . .	July 1937.
10	Four New Indian Ichneumonidae . . .	R. A. Cushman	December 1937.
11	The Silviculture & Management of the Bamboo ( <i>Dendrocalamus strictus</i> , Nees).	P. N. Deogun.	June 1937.
12	Indian Terminallia of the Section of Pentaptera .	C. E. Parkinson	July 1937.
13	Immature Stages of Indian Coleoptera (21) Cleridae	J. C. M. Gardner	July 1937.
14	A Synecological Study of the Forests of Western Sindh with special reference to their Geology.	H. F. Mooney	March 1938.
15	Immature Stages of Indian Coleoptera (23) Carabidae.	J. C. M. Gardner	March 1938.
16	New Indian Curculionidae (Col.) . . .	Sir Guy A. K. Marshall.	(May 1938.)
17	Immature Stages of Indian Lepidoptera . . .	J. C. M. Gardner	(July 1938.)
18	A Guide to the Insects of <i>Dalbergia sissoo</i> for Forest Officers	....	(May 1938.)
19	Ascu—A Wood Preservative . . .	....	(July 1938.)
20	A Note on Protecting Indian Structural Timbers against fire, termites & fungi (Rot) ( <i>Reprint</i> ).	S. Kamesam . . .	(August 1938.)
OTHER PUBLICATIONS.			
21	Annual Return of Statistics relating to Forest Administration in British India, 1935-36.	....	December 1937.
22	Forests in relation to Climate, Water Conservation and Erosion.*	....	June 1937.
23	The Forest Research Institute & College, Central Library, Classified Catalogue, 1934.	....	(May 1938.)
24	Mercer's Tables ( <i>Reprint</i> ) . . .	L. Mercer & Nand Mal.	January 1938.
25	Progress Report on Forest Research work in India, Part II.—Provincial Reports, 1935-36.	....	May 1937.
26	Progress Report of Forest Research in India, Part I.—Forest Research Institute, 1936-37.	....	December 1937.

\* (Extracts from the Proceedings of the British Empire Forestry Conference, South Africa, 1935, reprinted.)

## Publications of 1937-38—contd.

Serial No.	Title of Publication.	Author.	Date of issue.
27	Progress Report of Forest Research in India, Part II—Provincial Reports, 1936-37.	....	March 1938.
28	Classified List of Officers of the Indian and Provincial Forest Services and of the Indian Forest Engineering Service in India on 1st July 1937.	....	March 1938.
29	Annual Return of Statistics relating to Forest Administration in British India, 1936-37.	....	(November 1938).
30	Progress Report of the Forest College, Dehra Dun, 1936-37.	....	November 1937.

## Contributions to Scientific Periodicals.

## Silviculture.

- Champion, H. G. . . . Some Notes on the Kamrup method of Sal Regeneration (*Indian Forester*, Vol. LXIII, p. 134).
- Hall, W. T. . . . Cultivation of Exotics in Kulu (*Indian Forester*, Vol. LXIII, p. 512).
- Sen Gupta, J. N. . . . Forests of Upper Assam, Parts I and II (*Indian Forester*, Vol. LXIII, p. 734, and Vol. LXIV, p. 15).
- Sen Gupta, J. N. . . . Stand Improvement (*Indian Forester*, Vol. LXIII, p. 236).
- Trevor, Sir Gerald . . . Propagation of Selected Type of Forest Trees (*Indian Forester*, Vol. LXIII, p. 575).

## Entomology.

- Gardner, J. C. M. . . . Biological Control of Forest Insects (*Indian Forester*, Vol. LXIII, p. 769).

## Botany.

- Raizade, M. B. & Verma, B. S. . . . Indian plants reputed as fish poisons (*Indian Forester*, Vol. LXIV, p. 198).

## Utilization.

- Trotter, H. . . . Brush Treatments with Wood Preservatives (*Indian Forester*, Vol. LXIV, p. 112).
- Trotter, H. . . . Note on the Comparative Strengths of Sapwood and Heartwood (*Indian Forester*, Vol. LXIII, p. 598).
- Trotter, H. . . . Open Tank Treatment with Ascu (*Indian Forester*, Vol. LXIII, p. 672).
- Kamesam, S. . . . Standardisation of treated wood pole sizes for overhead electrical transmission supports (*Indian Forester*, Vol. LXIV, p. 43).
- Kamesam, S. . . . Role of treated timber in Indian structural economy (*Indian Forester*, Vol. LXIII, p. 311).
- Kapur, S. N. . . . Drying Wood by ultra-short waves (*Indian Forester*, Vol. LXIII, p. 248).

## Chemistry.

- Krishna, S., & Puntambekar, S. V. . . . The oil from the seeds of *Ximenia americana*, Linn. A New Unsaturated Fatty Acid, Ximenic Acid. [*Jl. Ind. Chem. Soc.* 15 (1937), p. 268-74.]
- Krishna, S., & Ghose, T. P. . . . Occurrence of Rotenone in *Milletia pachycarpa*. (*Current Science*, August 1937, p. 57.)
- Krishna, S., & Ghose, T. P. . . . Indian *Tephrosia* sp. as a source of Rotenone. (*Current Science*, March 1938, p. 454.)

## APPENDIX II.

*Publications of the Forest Research Institute, Dehra Dun,  
available for Sale.*

## SILVICULTURE SERIES.

## BULLETINS (Old Series).

	PRICE. Rs. A. P.
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## PAMPHLETS.

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2. Memorandum on Teak Plantations in Burma, by F. A. Leete . . . . .	0 10 0
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## APPENDIX III.

*Statement showing Officers-in-charge of Branches and Sections during the year 1937-38.*

Branch.	Officer-in-Charge.	Section.	Officer-in-Charge.	From	To
Silviculture .	Mr. M. V. Laurie, Silviculturist.	..	..	1-4-1937	31-3-1938
		Experimental .	Mr. J. N. Sen Gupta	1-4-1937	31-3-1938
		Statistical .	Mr. M. A. Kakazai	1-4-1937	17-4-1937
			Bakshi Sant Ram	18-4-1937	31-3-1938
Botany .	Mr. C. E. Parkinson, Forest Botanist.	..	..	1-4-1937	16-10-1937
	Dr. N. L. Bor, Forest Botanist.	..	..	17-10-1937	31-3-1938
		Mycology .	Dr. K. D. Bagchee	1-14-1937	31-3-1938
Utilisation .	Mr. H. Trotter, Utilisation Officer.	..	..	1-4-1937	31-3-1938
		Minor Forest Products.	Mr. H. Trotter .	1-4-1937	31-3-1938
		Timber Testing	Mr. V. D. Limaye.	1-4-1937	31-3-1938
		Wood Preservation.	Mr. H. Trotter .	1-4-1937	31-3-1938
		Seasoning .	Dr. S. N. Kapur .	1-4-1937	31-3-1938
		Paper Pulp .	Mr. M. P. Bhargava	1-4-1937	31-3-1938
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1937	31-3-1938
		Wood Workshop	(Mr. H. Trotter) .	1-4-1937	23-11-1937
Entomology .	(Mr. J. C. M. Gardner.)	..	..	1-4-1937	31-3-1938
	Dr. C. F. C. Beeson, Forest Entomologist.	..	..	7-10-1937	31-3-1938
		Systematic Entomology.	Mr. J. C. M. Gardner.	1-4-1937	31-3-1938
Bio-Chemical .	Dr. S. Krishna, Bio-Chemist.	..	..	1-4-1937	31-3-1938
Timber Development Branch.	Mr. S. Kamesam, Timber Development Officer.	..	..	1-4-1937	13-5-1937
	(Mr. L. R. Sabharwal.)	..	..	14-5-1937	8-8-1937
	Mr. S. Kamesam .	..	..	9-8-1937	16-2-1938
	(Mr. L. R. Sabharwal.)	..	..	17-2-1938	31-3-1938

## APPENDIX IV.

ANNUAL FORM No. 24.

FOREST RESEARCH INSTITUTE.

*Summary of Revenue and Expenditure during 1937-38.*

Budget Heads.	Direction.	Silvicultural Branch.	Botany Branch.	Entomology Branch.	Utilisation Branch.	Chemistry Branch.	Timber Development Branch.	TOTAL.
1	2	3	4	5	6	7	8	9
REVENUE.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
V.—Miscellaneous—								
(a) Fines and Forfeitures.	8	..	..	..	..	..	..	8
(b) Other sources .	40,446	77	220	22	8,715	288	..	49,768
(c) Leave contribution of officers on foreign service.	..	..	..	..	..	..	..	..
(e) Sale of timber and furniture from seasoning and Wood Workshop depot.	..	..	..	..	2,534	..	..	2,534
Total Revenue .	40,454	77	220	22	11,249	288	..	52,310
EXPENDITURE.								
C.—Conservancy, Maintenance and Regeneration—								
C. 1.—Purchase of stores, tools and plant.	340	879	509	68	1,413	90	167	3,466
C. 2.—Communications and buildings, Repairs, Maintenance.	..	..	..	..	..	..	..	..
C. 3.—Miscellaneous—								
(1) Temporary Establishment on daily labour.	456	1,064	4,804	3,282	3,708	..	149	12,958
(2) Purchase of Timber for seasoning and preserving (including freight and cartage charges).	..	..	..	..	3,886	..	..	3,886
(3) Purchasing of coal, raw materials, chemicals and apparatus.	..	..	..	574	12,475	2,078	..	16,127
(4) Other Charges .	338	3,456	2,417	819	20,820	397	13	28,256
Total C.—Conservancy, Maintenance and Regeneration.	1,129	5,399	7,230	4,743	42,302	2,565	329	63,687

## Summary of Revenue and Expenditure during 1937-38—contd.

Budget Heads.	Direction.	Silvicultural Branch.	Botany Branch.	Entomology Branch.	Utilisation Branch.	Chemistry Branch.	Timber Development Branch.	TOTAL.
1	2	3	4	5	6	7	8	9
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
B.—Establishment—								
I.—Pay of Officers—								
(a) Superior officers	20,996	12,900	6,667	27,880	20,190	..	..	88,333
—Non-Voted.								
(b) Superior officers	300	14,419	28,968	14,146	83,058	26,629	9,860	1,77,880
—Voted.								
II.—Pay of Establishment.	39,705	22,861	9,411	22,876	97,487	6,555	1,848	2,00,743
III.—Allowances—								
(b) House rent and other allowances	585	..	..	..	..	..	..	585
—Voted.								
Travelling allowances—								
(d) Superior Officers—Non-Voted.	232	2,633	1,702	1,802	1,461	..	..	7,830
Voted—								
(e) Subordinate Forest and depot establishment.	1,600	2,600	2,741	2,803	4,130	743	1,536	16,153
(f) Office establishments.								
IV.—Contingencies—								
(a) Stationery	102	3	26	6	8	..	..	145
(b) Carriage of records and tents.	292	821	670	474	380	..	45	2,682
(c) Rents, rates and taxes.	6,601	105	221	4	170	..	..	7,101
(d) Pay of menials	..	..	..	..	..	..	..	..
(e) Official postage	1,761	351	355	251	787	46	990	4,521
(f) Sundries	12,546	486	686	1,533	4,259	635	2,736	23,670*
(g) Clothing and uniforms.	473	85	87	84	311	31	17	1,068
(A) Telephone.	867	312	312	351	1,027	140	138	3,147
V.—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-Voted).	..	600	234	1,200	..	..	..	2,034
Total B.—Establishments.	86,010	57,876	52,080	73,410	2,13,248	34,779	17,170	5,35,362*
GRAND TOTAL OF ALL EXPENDITURE UNDER 10.—FORESTS.	87,139	63,265	59,310	78,153	2,55,550	37,344	17,499	5,99,011*
Major Head 8-A.—Share of Capital charges financed from ordinary revenue.	..	..	..	..	..	..	..	..
Surplus or Deficit	- 16,685	- 63,188	- 59,090	- 78,131	- 2,44,301	- 37,056	- 17,499	- 5,46,739*

\* Details for the distribution of Rs. 789 included in these figures on account of publications through High Commissioner are being obtained from the Accountant General, Central Revenue, New Delhi.

NOTE.—The figures given in the statement have been prepared in the President's Office and are based on the summary of Revenue and Expenditure for March 1938 received from the Accountant General, Central Revenue. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenue, on account of leave salary, exchange accounts with other Governments and Expenditure incurred through High Commissioner on miscellaneous items.

L. MASON,

President,

Forest Research Institute and College.

# FOREST RESEARCH IN INDIA, 1937-38

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**PART II.—PROVINCIAL REPORTS.**



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# FOREST RESEARCH IN INDIA, 1937-38.

## PART II.—PROVINCIAL REPORTS.

### CHAPTER I.

#### *Silviculture.*

A large number of sample plots was laid out by the F. R. I. party for teak and sandal in Coorg and for a number of species in the Andamans. The Coorg plots included replicated comparative thinning sets which should yield valuable results in time. Plots of the all-India co-operative bamboo management investigation in several provinces were remeasured and inspected by F. R. I. parties, and a number of improvements introduced.

*Assam.*—Natural regeneration of evergreen forests has been satisfactory in the Jaipur reserve where an experiment has been started for gradually lifting the canopy. In the Kamrup division, much progress has been made in establishing whippy regeneration of sal by controlled burning and rains weeding including pulling out of *Eupatorium*. Here, as well as in Kachugaon and Haltugaon divisions, systematic burning of sal forests is being done as a routine measure. Considerable progress has been made in the preparation of working plans and 10-year divisional plantation schemes.

*Bengal.*—In the *bhabar* sal forests experiments on successive annual burning have tended to lighten the undergrowth as well as to increase seedling recruitment of sal. Elsewhere, in moister sal areas, the policy of slow burning has been successful in killing out or reducing the luxuriant evergreen undergrowth; and it is hoped drier conditions favourable to sal regeneration will soon follow. The annual controlled burning in sal plantations for 9 successive years has changed evergreen undergrowth towards drier types.

In the Kasalong valley evergreen forests, the divisional experiments have given indications that large gaps in natural regeneration caused by exploitation fellings followed by mechanical extraction by tractor will have to be aided by artificial regeneration of fast growing plants.

Some amount of success has been obtained for the first time under the well-known "Kamrup method" for regenerating typical garjan (*Dipterocarpus* spp.) forests at Bhomoriaghona, Cox's Bazar. The canopy was slightly opened by the removal of suppressed middle storey, the congested patches were thinned, undergrowth cut and burnt and the area was cleaned with the result that there was a profuse recruitment of healthy seedlings. Experiments to introduce *Dipterocarpus turbinatus* and *Eugenia grandis* under high shade by notching on a bigger divisional scale proved very successful and at a low cost.

In the case of *Nipa fruticans* (golpatta) in the Sunderbans, it was found that if an extra utilisable leaf were retained in each clump in addition to the unopened (or insufficiently opened) frond or fronds, there was an appreciable increase in the production of new shoots.

**Bihar.**—Observations on the effects of contour trenching on growth and water conservation have been continued, and the area trenched has been considerably extended. Successful reclamation work in heavily eroded soils has been effected by contour trenching followed by ploughing in seed of thatch grass or boga (*Tephrosia candida*) prior to the introduction of tree species. Controlled burning, as a regeneration measure, in dry sal forests is being given up in favour of complete fire protection.

**Bombay.**—As there was no special research officer, most of the local investigations were taken up by the territorial staff. An attempt at introducing *Cassia siamea* on the sites of deserted cultivation in the Tansa catchment area (East Thana) was fairly successful. The 1935 experimental plots to ascertain the rate of growth of teak in plantation under different spacings (Dangs, Surat), measured up in 1938, indicate that an average spacing of 12'×12' is more advantageous in early years than that of 6'×6' or 9'×9' or 15'×15' in so far as girth increment is concerned, but the effect of the wider spacing on tree form and on establishment costs is not mentioned.

**Central Provinces.**—There is no difficulty in obtaining natural regeneration of sal in localities (Balaghat) where grass can be kept down by successful fire protection extending over several years and by light grazing and grass-cutting. Coppice regrowth is vigorous everywhere. Plantation costs have been reduced considerably and the cost of formation only of teak plantation amounted to Rs. 5 per acre. Successful agri-silvicultural work has been reported from some divisions (e.g., Yeotmal) and the method is being undertaken in localities where land-hunger is intense and cheap labour readily available.

Teak seeds kept in white-ant nests for a year after collection germinated readily when sown thickly in lines a few days before the monsoon set in. The *rab-cum-taungya* method is proving very successful in a number of places. The Forest Department is issuing propaganda leaflets

to make the public tree-minded and a small nursery is being maintained by the provincial silviculturist at Nagpur for raising suitable ornamental plants for sale.

*Lantana* has almost completely disappeared from fire-lines as a result of successive burning but not so elsewhere.

*Coorg*.—Experiments confirmed that sandal seed sown without pulp has given much higher germination than that with pulp. *Aleurites fordii* and *A. montana* germinated fairly well (the former better than the latter) at different nursery centres. These plantations in six localities are showing much promise. After a few years' experiments Coorg has also adopted premonsoon stump-planting of teak between the middle of April and the middle of May as standard practice.

Frill girdling and poisoning with sodium arsenite in evergreen forest regeneration areas killed more than 50 per cent. of the trees resulting in vigorous response by the seedlings underneath.

*Madras*.—Regeneration of dry fuel forests by the "rab" method and its combination with the raising of field crops (*rab-cum-kumri*) has been extended and improved. In many districts with the most unpromising soil and climatic conditions success with this kind of work is now a matter of routine. Great benefits obtained by soil working by forking in the early stages of the "rab" regeneration of dry fuel forests have been demonstrated further. Success has continued in the control of new outbreaks of the spike disease of sandal. Investigations into the best date of stump-planting and best size of stumps to use have been concluded for most of the important local species. In years of seed shortage, undersized teak stock in the nursery can be developed into good stock for the following year. The change in the technique of raising plantations by premonsoon stump-planting in crowbar boles and the improved weeding and tending methods have reduced the cost of formation of plantations by Rs. 10 to Rs. 15 per acre.

*North-West Frontier Province*.—The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*) and silver fir (*Abies pindrow*) specially in forests under the uniform system. Previous experiments to ascertain the most suitable intensity for a seeding felling in blue pine forests having given no definite results have now been given up and a new set of experimental plots laid out in their place to study factors affecting the progress of seedlings in recruitment and also to study the effect of grazing, of removal of *Viburnum* weed and of exclusion of rodents.

Sowing of deodar on burnt patches continues to give very good results in the blue pine regeneration area in Upper Siran range.

In chir (*Pinus longifolia*) regeneration areas, where the young crop is established, the effect of increasing grazing incidence from 8 acres to 6 acres per head of cattle continues to be beneficial.

*Orissa*.—The main problem in Angul (old P. B. I. areas) is to find out how best to assist sal (*Shorea robusta*) regeneration against *Bambusa arundinacea*. Burning the clumps was not so effective as clearfelling. Experiments to raise teak stumps in dry *rab* nurseries proved successful in Angul, promising economy in nursery costs and reduced expense in carriage of plants to the planting site.

*Rab* sowings have successfully been made in several Divisions even on poor dry soil with various species. Sandal sowings under bushes with existing forest trees as hosts have given far better results than have clean weeding and sowing of host plants.

In Puri, *dona* (leaf cup) planting of teak gave very good results. Initial results from underplanting of *D. strictus* forest with teak stumps are promising.

*Punjab*.—Observations in high level *kail* (*Pinus excelsa*) forests as well as in mixed *kail* and *fir* forests showed distinct improvement in natural regeneration where humus was scraped off or burnt.

As regards *Abies pindrow* and *Picea morinda* previous years' observations were confirmed, namely that the removal of humus and exposure of mineral soil gave significantly better results, and that the influx of regeneration was inversely proportional to the opening of canopy. Under strip fellings seedlings were more numerous in 50' and 75' strips as compared with wider strips, and under-sheltered reproduction was distinctly better in 20'  $\times$  30' gaps than in bigger openings.

*Morus alba* and *Melia azedarach* underplanting in irrigated plantations of *Dalbergia sissoo* was very successful in Multan, Montgomery and Research divisions. *Cryptomeria japonica* and *Cupressus torulosa* did well in Kangra oak forests (Dharamsala) and *Prosopis juliflora* (Argentine form) did well in poor soil in irrigated plantation and together with arid and Mexican forms in dry foothill scrub areas. Agaves were found highly useful for erosion control. The erosion control work at Nurpur furnished a demonstration that after 3 years' closure the growth of grass had markedly improved and several indigenous plants made their appearance and are beginning to cover the ground. Clearfelling in winter followed by trenching in spring to get root suckers proved to be the best method for naturally regenerating *Dalbergia sissoo* high forest in riverain areas.

Planting espacement (*Dalbergia sissoo*) experiments at Chichawatni initiated in 1928 were closed. Results showed that closer espacements, i.e., 5'  $\times$  10' and 6'  $\times$  10', give higher outturn than 8'  $\times$  10' or 10'  $\times$  10' and are moreover better for controlling weed growth.

*United Provinces.*—The question of obtaining and establishing sal regeneration *de novo* continues to be the most important item in the programme.

Rains shrub-cutting is being successfully adopted in a fairly large scale in regeneration areas in the Haldwani, Ramnagar, Tarai and Bhabar Estates forest divisions.

Khair (*Acacia catechu*) trees, even large ones, produced coppice shoots if the roots were wounded below ground level after felling (Tarai and Bhabar Estates). In artificial regeneration khair cannot be successfully raised without rains weeding.

In S. Kheri and Pilibhit divisions the *baib* grass (*Pollinidium angustifolium*) plantations continue to be very successful on suitable areas,—some plots producing as much as 58 mds. per acre. Indications are that best results are obtained with a spacing of 2' × 2'.

In underplanting experiments, *Eugenia jambolana* and *Holoptelia integrifolia* have developed well under dense khair (*Acacia catechu*) shade.

### Botany.

The province of Assam continues to make contributions to the science of botany. Several new species were described and Volume II of the Flora of Assam was published during the past year. A very valuable collection of the woody and herbaceous flora of Assam, which is housed in Shillong, makes possible such additions to knowledge. One learns with considerable surprise that the staff which looks after this asset is still, and has been for many years, on a temporary basis.

The identification of the species of the evergreen forests has at last been taken in hand. The Forest Botanist paid a visit to South India during the last cold weather and dealt with about 7,000 trees in several parts of Madras.

The result of trenching the arid hills of Bamiaburn continues to attract attention. Far-reaching claims of success in changing the ground cover, in improving the growth of the trees and in altering the local climate have been made, but unfortunately no data of the untouched site are available for comparison. It is hoped that an ecological survey in the cold weather of 1938 will throw some light on the matter.

### Utilisation.

In the sphere of Utilisation, there is much of interest to be read in the Provincial reports.

Assam, Bengal, the Central Provinces, Madras, and the United Provinces all maintained a Forest Utilisation Officer either throughout the

year, or for part of the year. Bihar and the Punjab maintained Forest Research Officers who dealt with Utilisation problems as well as those of Silviculture and other branches of forestry.

On the whole, the provincial utilisation reports are very encouraging, and amply demonstrate how a Utilisation Officer can help in tackling specific problems and assist generally in improving trade in forest products and finding new markets where required.

*Assam.*—The Forest Utilisation Officer, as usual, showed great activity in trying to find markets for his province's timbers. He reports that a large seasoning kiln is to be erected by the Surma Valley Saw-mills, which will greatly assist this firm to market their timbers in clean condition. He also reports that by using proper methods of air seasoning, the Assam Railway and Trading Company obtain 50 per cent. higher prices for air-seasoned timber than they do for green wood.

Several timbers were tried for pencil manufacture, but except for *Bischofia javanica*, which was reported as the "most suitable", none of the nine timbers tried were found suitable. *Bonsum* (*Phæbe goalparensis*) is said to be suitable for shuttles and is being used for this purpose in increasing quantities for handloom work. *Amoora wallichii* is reported on as being a favourite timber for furniture.

A match factory in Calcutta is taking *bhelu* (*Tetrameles nudiflora*), *pitali* (*Trewia nudiflora*) and *kadam* (*Anthocephalus cadamba*) for match work as substitutes for semul (*Bombax malabaricum*), supplies of which are inadequate to meet the demand.

As regards minor products, *Millettia pachycarpa* roots were tested for their rotenone content and were reported on as containing 2.8 per cent., a very encouraging result. The trade in canes was brisk, and prices rose by 15 to 50 per cent. The price of *Plumbago rosea* also increased to nearly double last year's figure, and the trade in several other products was brisk.

Finally the Utilisation Officer obtained a reduction in railway freight for many forest products, and it is anticipated that the new rates will benefit both the Forest Department and the Railway concerned.

*Bengal.*—The Forest Utilisation Office of Bengal is now in Calcutta, and the Forest Utilisation Officer reports that, judging by the increasing number of enquiries and requests for advice that he receives, the moving of the office from Darjeeling is more than justified.

It is emphasized that Calcutta is the largest individual market for timber in India, and that, although the potential provincial forest output is not fully sold, enormous quantities of timber are being imported into Calcutta. In the month of March 1938, no less than 8,000 tons of timber were imported into the town by sea alone. A very large

quantity of this is, of course, teak from Burma, but, nevertheless, there is scope for expansion of the Bengal trade in forest produce.

Numerous samples of timber were sent out by the Forest Utilisation Officer with the object of having the timbers tried for various purposes. Success was achieved in some instances. *Sonneratia apetala* was accepted for heavy packing cases, and *Bischofia javanica*, *Amoora wallichii*, *Cedrela microcarpa* and *Cedrela toona*, were accepted by a firm of pencil and pen manufacturers, for pencil making. The wood chiefly used by the same firm for cheap pencils is *Carapa obovata*, but supplies are limited and sizes are small. *Xanthoxylum budrunga* was tried for furniture making but proved very refractory.

**Bihar.**—Bihar reports that success was achieved in obtaining a reduction in railway freights on charcoal, and the Forest Research Officer was very active in the propaganda field. Pictorial post cards on forest subjects were widely distributed, and the Forest Department took part in exhibitions at Khunti, Ranchi and Calcutta. It is also reported that in Bihar propaganda and education of the general public and of engineers in forest and utilisation subjects is of paramount importance, and active steps are being taken to fill the want. One method proposed is the circulation of timber engineering magazines to the engineers of the province by the Forest Department. This is a sound policy which might well be followed by other Provinces. *Albizia procera* was tested by a Patna firm for gun stocks and was reported on as suitable if well seasoned and free of cracks. A small tool handle business was started in Chakradharpur, the main timber to be used being *dhaura* (*Anogeissus latifolia*). The woods being used by match factories are reported to be *salai* (*Boswellia serrata*), *char* (*Buchanania latifolia*), *amra* (*Spondias mangifera*) and *semul* (*Bombax malabaricum*).

A start has been made in supplying poles for electric transmission work, and orders for more poles have been received. A scheme for the electrification of the whole Province is under consideration. If it eventuates, at least 10,000 poles will be required. The question as to whether palmyra poles will be suitable for this scheme is being investigated. An Ascu treating plant was erected at Goikera.

**Central Provinces.**—The Central Provinces also report an increased trade in electric transmission poles. Orders for poles of both teak and *Polyalthia cerasoides* were booked. The Allapilli sawmill cut 81,442 cubic feet of timber, and sold over 78,000 cubic feet for Rs. 1,32,012.

Over 95,000 sleepers were supplied under a 3-year contract to the Railways. A Bombay firm investigated a scheme for the utilisation of *Dendrocalamus strictus* bamboos for paper-making. If the scheme eventuates the mill will probably be erected either at Chanda or Ballarshah. A Delhi firm made enquiries as to the possibility of using *salai*

(*Boswellia serrata*) for plywood. *Gardenia latifolia* is being tried by the Linen Industry Research Association, Ireland, for spinning rollers.

In minor products, lac still holds pride of place, but the price for T. N. fell from Rs. 24 to Rs. 15-8-0 per maund. There was an improvement in the demand for *rusa* grass, and the leases fetched Rs. 5,319 as against Rs. 2,100 the previous year. The demand for *kulu* (*Sterculia urens*) gum also increased, but prices kept low. Over 75,000 cwts. of this gum were exported from Bombay alone during the year. An investigation to improve the tapping of *kulu* gum is under way. Other products showing increased trade include *katha*, *tendu* (*Diospyros melanoxylon*) leaves, and *harra* (myrabolams).

**Madras.**—Electric transmission poles were a subject of increased interest in this Presidency also, and schemes for the treatment of poles for hydro-electric work were submitted to Government. Both Ascu treatment and open tank treatment with creosote are under consideration. At the same time, the Kodaikanal Municipality are purchasing and erecting poles of *Pinus insignis* treated by the Osmose process. The results will be watched with interest. The question of the proper seasoning of sleepers has also been taken up. *Botha* grass (*Cymbopogon coloratus*) was sent to Dehra Dun for pulp and paper tests. It was found suitable for cheap grades of paper if mixed with other long-fibred materials such as bamboo pulp. Samples of 6 timbers were sent to Dehra Dun for shuttle tests. *Evodia roxburghiana* was reported on by the Western India Match Co. as suitable for splints. *Ailanthus malabarica* is also reputed to be an excellent match wood, but supplies are scarce. Nineteen woods were tried by the Madras pencil factory for pencil work but none of them proved suitable.

Casuarina is to be tried for pole work. The Forest Department participated in provincial exhibitions at Salem, Calicut and Madras.

In minor products, *Nux-vomica* seeds showed a drop in price from Rs. 11-4-0 to Rs. 8-4-0 per candy. Imported wattle bark showed an increase over last year's prices, but *Cassia auriculata* bark prices declined. Experiments on the collection of this bark showed that one year old shoots had a tannin content of 16 to 20 per cent., while 2 and 3-year old shoots only increased in tannin content by 2 to 3 per cent. Enquiries for *kulu* (*Sterculia urens*) bark were received in this Province also.

**North-West Frontier Province.**—Sample logs of sissoo (*Dalbergia sissoo*) from the Lower Swat Canal banks were sent to the Forest Research Institute for testing for veneers. It was found to be highly decorative, and samples were shown at the Lahore Exhibition in December 1937.

**Orissa.**—The Mahanadi river in Barapahar division has been made possible for floating bamboos by blasting operations, and successful

floating operations have been undertaken. The Public Works Department have installed an Ascu treating plant at Koraput, and the local Government has issued orders that preference should be given to provincial timbers for all public works. Treated wood bridges are to be used on the Koraput-Rhayagada road. The terms of the bamboo lease for the Orient Paper Mills have been settled, and it is expected that the mill will start work in 1939.

*Punjab.*—With a view to educate the public on forest matters a forestry pavilion was opened in the All-India Exhibition of Arts and Industries held at Lahore in December 1937. Exhibits included erosion, forest working and Punjab forest type models and various forest products which could form the basis for the development of cottage or large scale industries. Over 3 lakhs of people visited the pavilion in the course of two months and many of them displayed a keen interest in the development of forest industries (Research).

*United Provinces.*—The post of Utilisation Officer was revived in October 1937, and Mr. D. Stewart, Deputy Conservator of Forests, was given charge of the Division. He made a complete survey of the utilisation work in the Province during the working season 1937-38, and his able report is worthy of perusal by officers in other Provinces, as it gives a very clear account as to how a Utilisation Officer can help his Department and stimulate trade in forest products on sound lines.

The seasoning of sleepers for the railways and the supply of both softwood and hardwood sleepers was one of the first problems tackled. The supply of poles for electrical transmission work was another, and the importance of keeping proper records of poles in service is emphasized. *Kulu (Sterculia urens)* gum was a profitable product in this province also, while the possibility of utilising chir (*Pinus longifolia*) and ulla (*Anthisteria gigantea*) for paper pulp was also explored. So far the results on these products look promising for the manufacture of cheap wrapping papers. The provincial output of semul (*Bombax malabaricum*) for the match industry was carefully examined, and the possibility of starting a plywood factory in the Province was also explored. Unfortunately supplies of possible timbers for plywood work in the United Provinces are at present insufficient to support a plywood mill. Steps are being taken to increase the provincial supplies of timbers suitable for matches, plywood, and the box trade. Such timbers are in deficit in most provinces in India and the question of plantations is one which should receive, if it is not already receiving, attention by all provincial forest administrators.

## CHAPTER II.

### SILVICULTURE AND WORKING PLANS.

#### ASSAM.

##### I.—EXPERIMENTAL SILVICULTURE.

###### (i) *General.*

*Staff.*—The post of the Silviculturist continued to remain in abeyance throughout the year. Dr. N. L. Bor, Deputy Conservator of Forests, was in charge of the work, in addition to his duties as Botanical Officer, until the 10th October 1937, when Mr. R. N. De, Deputy Conservator of Forests, took over and held charge for the remaining period of the year. It has not yet been possible to get sanction for even the minimum office and field staff for the Silviculturist.

There were 18 silvicultural experimental plots (including three gardens) at the beginning of the year of which one experimental garden in the Sadiya division was made over to the territorial staff. Two new experimental plots were laid out, during the year, in the Lakhimpur division. Plantation schemes have been drawn up for most of the divisions.

###### (ii) *Natural regeneration, etc.*

As remarked last year, the natural regeneration of the evergreen forests is quite satisfactory in the Jaipur reserve where an experiment has been started of gradually lifting the canopy. Seedlings of *Dipterocarpus macrocarpus*, *Mesua ferrea*, *Shorea assamica*, *Manglietia insignis*, *Artocarpus chaplasha*, etc., are found almost everywhere under mother trees. In Cachar and Sylhet divisions, natural regeneration of *ping* (*Cynometra polyandra*), *kurta* (*Palaquium polyanthum*) and *Dipterocarpus turbinatus* is very good in places.

In the Nowgong division two experimental plots have been laid out for natural regeneration of *sal* by rains weeding and by clearing bamboos and trees in places where good whippy regeneration of *sal* already exists. Both the plots are promising.

In the Kamrup division much progress has been made with establishing whippy regeneration of *sal* by controlled burning, rains weeding and pulling out *Eupatorium*.

In the Kamrup, Kachugaon and Haltugaon divisions systematic burning of *sal* forests, is being done as a matter of routine.

(iii) *Investigation of seeds.*

Experiments for germination test of various species were continued in the Lawacherra experimental garden (Sylhet), and the experimental plot No. 11 at Holongapar (Sibsagar) was also reconstituted last year for the same purpose.

Routine pre-treatment of seeds was done with several species and a few species were sown untreated. On the average good germination results were obtained from the former. In shaded beds, untreated *Amoora wallichii* seeds gave the quickest germination and upto 95 per cent. Some *Talauma phellocarpa* seeds were treated with Hydrochloric acid before treatment, but no germination was obtained. *Xylia dolabriformis* seeds received from Burma gave very satisfactory results, with germination percentages of about 94 per cent. in shaded beds and 85 per cent. in unshaded beds. (It may be of interest to note that *Xylia dolabriformis* trees in the Lawacherra plantation raised from Burma seeds in 1927 flowered in 1937. Some seeds were sown in a nursery bed and were found to be fertile. *Terminalia tomentosa* and *Hydnocarpus kurzii* planted in 1927 also bore seeds in 1937.)

(iv) *Investigation on Trees and Crops.*

(a) *Phenological data.*—Observations were continued on all trees selected for the purpose in different divisions in order to get reliable averages.

(b) *Inheritance of individual characters.*—Experiments were continued to determine hereditary characters in the distinct growth forms of *Lagerstræmia flos-reginæ*.

(v) *Nursery Work.*

Two experimental nurseries are being maintained at Lawacherra and Holongapar. In hot dry areas, shaded nursery beds gave generally a higher germinative capacity with nearly all species tried. *Bonsum* (*Phæbe goalparensis*) started germination in December and continued till April in the Holongapar nursery. *Alseodaphne owdenii* seeds collected in the Cachar division did not keep well for more than 15 days after collection.

The experimental Cinchona plantation at Umsaw was maintained but it was decided not to extend this any more.

(vi) *Artificial regeneration.*

In nearly all divisions, plantations are being raised either departmentally or by *taungyas* and much useful information is being collected,

(vii) *Tending.*

Due to the introduction of plantation schemes, systematic tending of all plantations will now be ensured.

(viii) *Mixtures.*

Except in the *sal* forests, mixture of species is being introduced in almost all divisions and species suited to the locality has been prescribed in all plantation schemes.

(ix) *Underplanting.*

Underplanting of *gamari* (*Gmelina arborea*) by *cham* (*Artocarpus chaplasha*) in the 1929 plantation of the Raghunandan reserve was a great success and during the year under review a number of *gamari* trees were removed in thinning so as to admit more light to the *cham*.

In the 1935 *gamari*, *garjan* (*Dipterocarpus turbinatus*) underplanting in quincunx looks very promising and some of the *garjan* are as high as 8'.

(x) *Silvicultural systems.*

Working plans for the Kamrup and Goalpara forests are under revision and the shelter wood compartment system has been prescribed.

(xi) *Miscellaneous.*

(a) *Preservation Plots.*—These have now been selected in almost all divisions of the province and attempts are being made to systematize their records.

(b) *Cinchona plantation.*—The extension of the plantation at Umsaw in the Khasi and Jaintia hills has been stopped and the experimental plantations in the Garo and Mikir hills were also previously abandoned.

It has been found by analysis of the specimens of *Cinchona* sent that the alkaloid content is not inferior to that raised on a commercial scale in the Bengal plantations.

Mr. Wilson, *Cinchona* Expert of the Imperial Council of Agricultural Research, visited the Umsaw and the Mikir Hill plantations along with a Soil Chemist. It is understood that the growth of *Cinchona* plants is, according to Mr. Wilson, quite satisfactory at Umsaw and the soil is also suitable.

## II.—WORKING PLANS AND STATISTICS.

(a) *Preparation and Control of Regular Working Plans.*

The working plan of the Nowgong and six reserved forests of the Sibsagar division has been brought into force in Nowgong with effect from the 1st August 1936.

The working plans for the Cachar and Sylhet divisions have been completed and sanctioned by Government.

Rapid progress has been made during the year in the revision of the working plans of the Kamrup and Haltugaon (Goalpara) divisions. They are both expected to be completed by the end of the year 1938.

A working scheme has also been prepared for the Nongkhyllam and adjacent Siem's forest in the Khasi and Jaintia hills.

Considerable progress has been made in the preparation of 10-year divisional plantation schemes.

### (b) Preliminary Working Plan Reports.

The preliminary working plan reports for the revision of the Kamrup, Haltugaon (Goalpara) and Kachugaon (Goalpara) working plans were approved during the year.

## III.—MISCELLANEOUS.

1. *Photos*.—11 photos of forest importance were supplied to the Central Silviculturist, Dehra Dun, for circulation. The Silviculturist took many photos of plantations and other items of interest during his tour.

2. *Weeds*.—Grazing as a factor in keeping down the weeds is fairly obvious in the *sal* forests of the Kamrup division where villages exist near all forests. Experiments have been started in the Nowgong and Darrang divisions to keep down weeds by controlled grazing. Some success seems to have been attained, but no conclusion can yet be drawn.

*Loranthus* which was playing havoc with the *gamari* (*Gmelina arborea*) plantations of the Sylhet division has been tackled this year by lopping the affected branches. The effect will be watched with a view to find out if the method is successful and cheap. *Sal*, *ajhar* (*Lagerstroemia-flos-reginae*) and other species are also attacked by this pest.

## BENGAL.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) General.

Mr. J. C. Nath, Deputy Conservator of Forests, was in charge of the Silvicultural division, while the post of the Assistant Silviculturist was held by Mr. S. C. Chatterjee, Extra Assistant Conservator of Forests, throughout the year except for four months (July-November) when he was on leave, and Mr. S. K. Datta, Extra Assistant Conservator of Forests, was in charge.

(ii) *Natural regeneration.*

(i) *Sal*.—In the Buxa division, attempts to naturally regenerate areas in the *bhabar* tract were continued. The luxuriance of the undergrowth has been considerably reduced and a slight increase of *sal* seedlings was noticed.

In the Raimatang *bhabar* also a fair number of seedlings in the unestablished stage are at present scattered all over the area, and the undergrowth is getting lighter by repeated annual burning, though the replacement of *Pollinia ciliata* by *Imperata arundinacea* is slow.

The experiments started last year, in order to study the applicability of the Kamrup method, in Kurseong, Buxa and Jalpaiguri divisions, were maintained. It was noticed at the end of the year that the recruitment of *sal* was more or less present in every type of forest. These experiments, however, have not been long enough in existence to yield definite results.

The policy of attempting to cold burn was continued in all *sal* areas that were similarly treated last year, with the result that much of the luxuriant evergreen undergrowth appears to have been killed out. It is hoped that repeated burning will result in drier conditions favourable to *sal* regeneration.

In the Darjeeling division the experimental plot at Ryang in the Tista Valley was maintained. The indicator plots are now fully stocked with seedlings in the unestablished stage.

In the Dacca-Mymensingh division, where natural regeneration is of secondary importance as coppice regeneration is quite satisfactory, a careful study of the growth of natural seedlings and their advance to the established stage, to replace casualties in coppice stools or to fill up blank areas, was continued.

(ii) *Other species*.—(a) Experiments started last year in Jalpaiguri division to study the effect of a burn of moderate intensity on the existing reproduction of *khair* (*Acacia catechuoides*) and *sissoo* (*Dalbergia sissoo*) in the savannah areas in riverain forests, and also to see if the treatment would induce fresh regeneration, were maintained. These have yielded no positive results yet. Early burning of similar areas in the Diana and Torsa forests was continued; it was not as a whole successful. There are different types of undergrowth, each of which requires to be burnt at a different time in the winter. The stock-mapping of these different types of grass undergrowth has been taken up and a sequence of burning will be decided on. The essential consideration is that the fire should not be so hot as to kill the regeneration beyond recovery or to damage the growing stock.

Experiments on similar lines started in Buxa division last year were also maintained in savannah areas and grassy blanks in high forest.

Early burning, combined with controlled grazing and broadcasting of seeds of miscellaneous species, has not yet produced any positive results.

(b) *Evergreen forests of Kassalong, Chittagong Hill Tracts.*—The experiments to determine a method of removing the existing overwood, which would ensure establishment of the advance growth of valuable species already on the ground, were maintained. Results of the last 8 years' work are very encouraging.

The large scale divisional experiment started last year was also maintained and another area of 50 acres was also taken up during the year for the purpose. The object of these divisional experiments is to find out whether, and at what stage, it will be possible to carry out concentrated fellings in such areas, as the success of departmental extraction depends on intensive fellings. The indications are pretty certain that the first stage of the work in both these plots will be based more or less on the principle that low shade is definitely harmful, and that large gaps in the canopy, caused by the exploitation fellings followed by mechanical extraction by tractor, where advance growth of the valuable species may be deficient or absent, will require such artificial aid as sowing or planting of seedlings of comparatively fast growth.

(c) *Dipterocarpus* spp.—The experiments in Cox's Bazar and Chittagong divisions on the regeneration of *Dipterocarpus costatus* and *Dipterocarpus turbinatus* were continued in their typical forests, mainly *Dipterocarpus costatus* in the top canopy, a sparse middle storey of mixed evergreen species, and an undergrowth of coppice and shrubs—situated on flat tops of ridges at Bhomariaghona. A certain amount of success has been obtained, for the first time, this year, under the "Kamrup" method in typical *Dipterocarpus* forest at Bhomariaghona. The canopy was slightly opened by the removal of suppressed middle storey, and a thinning in the congested patches was carried out; the undergrowth was cut and burnt and the area was cleaned, with the result that profuse recruitment had appeared and the seedlings were quite healthy with an average height of 7" at the end of the year.

The experiments to introduce *Dipterocarpus turbinatus* and *Eugenia grandis* under high shade by 'notching' on a divisional scale has proved very successful at a low cost as reported in last year's report. All these 'notching' experimental plots were continued to be maintained to study the effects of different methods and intensities of tending on the subsequent growth of *garjan* (*Dipterocarpus* spp.) plants.

Experiments on the 'notching' of *Dipterocarpus costatus* and *Dipterocarpus pilosus* were also continued, but with very little success.

Experiments on the tending of patches of pole crops of *garjan*, which occur sporadically throughout the Chittagong division, were continued. It appears that fire is harmful to the young *garjan*. The effect of

cutting back the miscellaneous species has not been very appreciable up to the end of the year.

(d) *Treatment of Nipa fruticans*.—The experiments, started last year in the Sundarbans division, to study the effects of different methods of treatment of this palm on the production of leaf and seed, in different types of area, were continued. It appears that there is an appreciable increase in outturn, viz., up to 18 per cent., if an extra utilisable leaf is also retained on each clump, in addition to the unopened frond or fronds and the insufficiently opened frond which is unfit for use. Whereas the other treatments, viz., non-retention of any extra utilisable leaf per clump or cutting the utilisable portions only of the leaves, have shewn negative results,—the decrease being as much as 40 per cent. in one plot. These experiments have not been long enough in existence to differentiate the effects of different treatments on the production of seed.

### (iii) Nursery and Plantation Work.

Nurseries were maintained at Takdah, Sukna, and Hazarikhil and a new nursery was opened at Khuntimari during the year.

*Takdah* (5,000' altitude, Darjeeling).—Seven species were sown during the year. Seedlings raised in previous years were planted out in the arboretum and divisional plantations. Of the exotics *Pinus khasya*, *Pinus thunbergii*, *Cupressus torulosa*, *Cupressus cashmeriana*, *Juniperus virginiana* and *Acacia dealbata* are showing the greatest promise.

*Sukna* (Kurseong).—Routine experiments were made on various indigenous and exotic species. *Sandal* (*Santalum album*) is showing promise of being successful in this climate—the maximum height of one year old plant being 3'-6". Of the exotics, *Cassia siamea*, *Aleurites fordii*, *Pterocarpus marsupium* and *Eucalyptus citriodora* and *Acacia lenticularis* continue to show rapid growth.

*Hazarikhil* (Chittagong).—Routine tests were carried out for numerous species. Among the exotics, *Xylia dolabriformis*, *Pterocarpus dalbergioides* and *Eucalyptus citriodora* continue to shew promise.

*Stump planting*.—Experiments with various species were continued in many divisions. In Darjeeling, stump planting in the spring and winter seasons has been undertaken with a view to find out the best season for planting.

*Layering*.—Owing to the difficulty of obtaining the seed, experiments with layering of coppice shoots of *Castanopsis hystrix* were initiated in Darjeeling, but so far without success.

"*Kharkhani*" areas.—Experimental sowings of *sul* in 1935 and 1936 on bumps in low-lying areas (*Kharkhani*) in Buxa, have progressed well

and similar humps were again so treated in the current year's plantations.

*Bamboos*.—Experiments started last year to examine the possibility of introducing the exotic *Bambusa polymorpha* (of Burma) in the poor dry deciduous forests at Baraiyadhala, Chittagong, were continued.

The Gobania experiments, Chittagong, to find out the best rotation and the best method of treatment of *Melocanna bambusoides* were maintained.

*Plantations of exotics in the Darjeeling hills*.—Experimental planting of exotics was continued during the year.

At Ramam (8,000' altitude), *Alnus incana* and *Larix leptolepis* are showing the greatest promise of success.

At Takdah (5,000' altitude), *Cupressus torulosa*, *Cupressus cashmeriana* and *Juniperus virginiana* are showing good growth.

Experiments to reduce the rate of growth of *Cryptomeria japonica* by close planting were continued both at Takdah and Bagora.

*Plantation technique in the Darjeeling hills*.—Line sowings of *Cedrela febrifuga* were successful in Tonglu (10,050' altitude), and the field nursery is the most economical method of raising plants of *buk* (*Quercus lamellosa*) and *phalant* (*Quercus lineata*).

Experiments to aid artificial regeneration with coppice were started during the year at Sonada (6,487' altitude); it is however too early to report results. Similar experiments with wide espacement of the planted species and the preservation of coppice to fill in the intermediate gaps are being tried.

For protection from frost and exposure to strong winds, new working schemes were introduced during the year in Darjeeling division, prescribing clear-fellings in contour strips instead of by whole blocks and compartments. In some plantations cutting of fodder was stopped in order that the growth of weeds and coppice might protect the planted seedlings from exposure. It seems that continual fodder-cutting after *taungya* also causes further deterioration of the soil.

*Mixtures in plantations*.—The policy of intimate mixtures, rather than strips of 5 and 7 lines of each species, and standard espacements of 4'×4' for species of slower growth and 12'×12' or 16'×16' for very fast-growing *Betula* species are being followed in the Darjeeling hills. Elsewhere the mixture of species in alternate bands or strips of lines seems better. It will, however, take considerable time to obtain conclusive results from these experiments in mixtures.

*Underplanting*.—Experiments with (i) *Dipterocarpus turbinatus*, (ii) *Dipterocarpus pilosus*, (iii) *Hopea odorata*, (iv) *Swietenia macrophylla* under *Gmelina arborea*; and (v) *Dichopsis polyantha* under *Gmelina*

*arborea* and *Tectona grandis*, and (vi) *Artocarpus chaplasha* under *Tectona grandis* were continued. Of these (i) and (ii) are inexpensive and very successful; (iii) shows some promise of success; (iv) appears to be fairly successful; and (v) and (vi) also seem to be fairly successful in spite of their comparatively slow growth.

*Thinnings*.—Experiments in earlier thinning of *sal*, viz., in 3-to 4-year old instead of in 6-year old plantations, with a view to reduce the tendency to form epicormic branches, were maintained; it appears that the thinned *sal* lines are slower in their height growth, while crown development has not yet taken place.

*Eradication of climbers*.—The coppicing of *sal* in plantations, badly damaged by climbers, e.g., *gurja* (*Tinospora cordifolia*) and *kanchu* (*Mucuna pruriens*), mentioned in last year's report, has now been adopted in all *sal* divisions in Northern Bengal, particularly in bad cases of climber infestation in *sal*.

The experiment to study the effect of a burn of moderate intensity on the incidence of *creepers*, laid out last year in Dacca-Mymensingh division, was maintained.

*Controlled burning in sal plantations*.—Controlled (cold weather) burning in *sal* plantations of over 8 years old, was carried out in Kurseong, Kalimpong, Buxa and Jalpaiguri divisions for the 9th year in succession. It has been observed that the undergrowth in all the burnt areas has been gradually changing to a definite drier type and the incidence of troublesome climbers has become less and the general appearance of these plantations more healthy.

All the experimental plots to study the effects of controlled burning on the undergrowth, crop, soil conditions and incidence of climbers were maintained. Results to date indicate that the operation is beneficial.

The experimental plot in Dacca-Mymensingh, laid out last year to watch the effect of a burn of moderate intensity on the incidence of a defoliator in *sal*, was continued; the defoliator damage was less during the year but this cannot be taken as a direct result of burning as the experiment has not long been in existence.

#### (iv) *Miscellaneous*.

*Loranthus*.—The work on the removal of all *Loranthus* attacked *gamar* (*Gmelina arborea*) in plantations at Kaptai (including two sample plots), was undertaken during the year and considerable progress has been made. Similarly all *Loranthus* found in plantations of *toon* (*Cedrela toona*) at Madarihāt were cut out and burnt before flowering with a view to minimise the spread of this parasite.

(v) *Preservation of Natural flora*.—A new plot was laid out during the year in savannah at Dantmara, Chittagong division. The total number of plots at the end of the year was 28.

*Special investigation*.—The Silviculturist undertook a special investigation on the possibility of augmenting the revenue from produce grown on the East Indian Railway land in Bengal and visited the area. He submitted his report, recommending experimental afforestation as a preliminary measure, to the Senior Conservator of Forests, Bengal, at the conclusion of his tour.

## II.—WORKING PLANS AND STATISTICS.

(i) The revision of the Working Plan for the forests of Darjeeling division has been taken up.

(ii) The revised Working Plans for the forests of Chittagong and Cox's Bazar were under compilation during the year.

(iii) The Working Plan for the forests of Dacca-Mymensingh division was completed during the year and sent to the Press.

### (iv) *Miscellaneous*—

1. Records of all measurements of scientific plots requiring computation were sent to the Central Silviculturist, Dehra Dun. There were 386 scientific plots at the end of the year and routine measurements and observations were done as usual.
2. *Measurement of Heartwood and Sapwood*.—Statements supplied by the Divisional Forest Officers will be tabulated and published as a bulletin.
3. *Ring countings and stem analyses*.—Silvicultural Bulletin No. 2 (part I), showing the Volume/Age curves of the more important species of the province, as reported last year, was still in the press at the close of the year. Further work on the stem analyses of important species was continued during the year.
4. A classified list, according to species and locality, of all the scientific plots maintained by the Silvicultural division, was prepared and sent to the press for publication as Bulletin No. 3.
5. The quinquennial research programme for the period 1938-43 was published after the close of the year.
6. *Records*.—The Specific and General Ledger files now number 230 and 173 respectively; and there are 646 photographs in the collection.

## BIHAR.

## 1.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

*Early Burning.*—Research in this Province has proved that “early burning” is not necessary for regenerating the *sal* forests except perhaps in the extremely moist types which are comparatively small in extent. In other places it does more harm than good, causing retrogression to a drier, more unhealthy type. Water instead of fire is now being experimented with.

*Erosion.*—A study of erosion run-off experiments by the Research Officer, in the Punjab, showed the value of long grass in checking run-off and soil losses. A tour through Kolhan division, during September 1937, revealed that outside the irrigated area of Bamiahuru, many of the hill slopes possess insufficient cover of trees, grass or undergrowth to check run-off completely.

*Contour trenching.*—Research into the effect of contour trenching on forest growth, soil moisture, and climate is proceeding systematically. Advice on climatic data to be collected, has several times been given by the Meteorologist, Alipore, Calcutta, to whom grateful thanks are due.

Climatic data of several stations surrounding Bamiaburu, are being regularly recorded as well as at Bamiahuru itself. Both temperature and rainfall figures are suggestive that contour trenching may be having a humidifying and moderating effect on the local climate, but it will not be possible to draw definite conclusions from such data for a number of years,—i.e. until sufficient figures have been collected to enable average figures to be obtained which will show significant differences irrespective of chance annual fluctuations. The fact that the number of rainy days at Bamiahuru is greater than those of other local stations with higher rainfall is also suggestive. It is further claimed that an improvement in site quality in the *sal* forests treated with contour trenching has resulted, but here again, owing to the impossibility of getting proper controls for comparison, it is not yet possible to substantiate these claims statistically.

There is no evidence to show that the intensity of the rain is increased. On the contrary the evidence at Bamiahuru shows that many of the rains are very light, or drizzles. No extra flooding of local rivers need, therefore, be apprehended,—in fact, irrigated forests will be more effective in holding up the run-off.

“Blank” areas [Experimental Plots 22(a), (b) and (c)] in four years show a noticeable progression towards the establishment of a *sal* pole

crop. It is estimated that the crop will be fully established ten feet high in less than ten years from now.

The cost of contour trenching incidentally works out at about Rs. 160 per mile or about Rs. 6 per acre with the trenches 70 yards apart. A new scheme was started in the Roro area, 10 miles of trenches being dug. The completed scheme, which joins up with and includes Bamiahuru, will comprise one hundred miles of trenches in an area about fifteen miles long by three to four miles wide in places.

#### (ii) *Natural Regeneration.*

In the dry types of *sal* forest in Bihar, it is found that burning tends to create a still drier type less favourable for regeneration. Burning as a regeneration measure is therefore being given up. The area of moist *sal* forest where fire might be of advantage in creating conditions favourable for *sal* regeneration is relatively small.

#### (iii) *Seed.*

*Pinus caribaea* seed received from the Forest Research Institute germinated well, and has done fairly well in spite of being reported as specially tender in its early stages.

#### (iv) *Nursery Work.*

Research in the Hinoo Nursery is being conducted into the merits of xerophytic species, mainly of the Punjab origin, for reafforesting dry blank areas. Research into the characteristics of boxwood and plank-wood species of other provinces continues.

Considerable economies in the cost of farmyard manure are being made by breaking down organic waste by the Indore method.

#### (v) *Artificial Regeneration.*

*Plantations.*—Costs in the Leda 13 plantation have been reduced to Rs. 10 per acre including nursery costs. Plants are now put out with the aid of string knotted at 6' intervals instead of the former costly staking method. Forty-seven acres of miscellaneous forest was clear-felled and planted up in this area, and 28 acres in blank areas of Leda 8, and 4 acres in Gonmore protected forest. *Teak* was mainly used. *Toon* is reported to be doing well.

In Kurchrutta, entire transplants of *Robinia pseudo-acacia* planted out in August failed to become established.

*Sabai* grass (*Pollinidium angustifolium*) plantation.—After yields had fallen steadily for a number of years, these rose in 1936 and 1937. The increase is attributed to the heavier rainfalls of those two years.

Manuring experiments with artificial manures, against a fire protected and fire burned plot, are inconclusive. All yields have risen due to heavier rainfall. The artificial manure is costly to purchase and it is doubtful whether even if an increased yield resulted it would compensate for the extra cost involved.

#### (vi) Reclamation and Afforestation.

*Reclamation of heavily eroded soils.*—Some success was obtained at Bichaburu (Chaibassa division) in reclaiming heavily eroded crumbly chromite soils and erodible clay soils by first digging contour trenches about 50 yards apart and then ploughing in sowings of thatch grass or *boga* (*Tephrosia candida*). Ploughing along the contours was found to be preferable to ploughing up and down the slopes. Tree planting done at the same time, using *Gmelina arborea*, teak, *Pterocarpus marsupium*, *Cassia siamea* and *Azadirachta indica*, was only partially successful in spite of the contour trenching. It is now considered advisable to fix the soil first by means of grass and *boga* before tree planting is undertaken.

*Reafforestation of blank areas in protected forests.*—The use of *boga* (*Tephrosia candida*) as a nurse crop and soil improver has been found beneficial in reafforestation of blank areas in localities which suffer from drought. Sowings of *boga* are ploughed in at the commencement of the rains—the ploughing being done along the contours. The *boga* lines were 2 feet apart with tree species planted in every third line. It is believed that alternate lines of *boga* and tree species 3 feet apart may be preferable.

There are indications that contour trenching may be of value in reafforesting dry blank areas. It appears to increase the soil moisture content helping the plants to carry through the succeeding hot weather.

#### (x) Silvicultural Systems.

*Bamboo rotation experiment.*—Experimental plots have been laid out in the Hinoo nursery, Ranchi, on rotations of 4, 5 and 6 years to discover which rotation is the best for working selected bamboo forests in the interests of the Turis,—bamboo basket-makers. Two felling cycles are arranged within each rotation, one for the basket-maker exploiting the immature culms and the other for the regular trader. Two series of plots are being provided, the one for basket making to exploit culms one year old, and the other culms of under one year.  $2N+6$  culms are to be left in each clump by trader,  $N$  being the number of new culms which appear in the clump each year. The plots will be repeated in forest divisions next year.

(xi) *Miscellaneous.*

*Soil Moisture Tests.*—Soil moisture tests taken at the hottest time of the year, when no rain had fallen for six weeks on contour trenched and untrenched land in the Namkum Lac Orchard near Ranchi, showed the contour trenched area, which in the previous monsoon had held up the run-off, to have greater moisture contents at the 1' and 3' deep levels. Such an increase would probably react favourably on the lac crop.

*Oecological observations.*—Spear grass (*Heteropogon contortus*) appears to be dying out at Bamiahuru and giving place to *Sabai* (*Pollinidium angustifolium*). *Strobilanthes auriculatus* is spreading.

The *sal* forest, contrary to expressed opinion, is not changing to mixed forest under irrigated influence. Dry peninsular *sal* forest appears to be changing to moist peninsular *sal*, and dry mixed forest to moist mixed in contour trenched areas.

*Fungal diseases.*—The incidence of fungal attack, by *Polyporus shorea*, *Fomes tricolor* and *Trametes inserta* seems to be greatest on dry soils and least on lateritic soils indicative of high rainfall. This will be verified by further observations.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

*Khurchutta Forests.*—Schemes have been included in the revised plan for contour trenching the whole of the "Old Reserves", and selected blocks of the new, in addition to "eroded" areas which are being planted up, in order to prevent the retained standards in the coppice forest from going top dry, owing to uncovering the forest floor in fellings, and to improve growth in a neighbourhood, where wood is scarce. Experience suggests that we should endeavour to improve the forest growth to its utmost capacity in such places in order to help to relieve the wood famine which prevails.

*Kodarma Plan.*—Khair working circles are to be introduced, and a Miscellaneous Working Circle with *salai* (*Boswellia serrata*) as the chief wood for export. Arrangements are being made in all plans for the introduction of rotational grazing where this is feasible.

## III.—MISCELLANEOUS.

(i) *Photography.*

88 photographs were taken by the writer during the year, 6 photographs were taken by the Conservator of Forests on irrigation, 4

were taken by the Divisional Forest Officer, Palamau, and 2 by the Silvicultural Ranger.

23 slides were also made from these photos to augment our subject material for lantern lectures. We have now a collection of 218 slides.

(ii) *Weeds.*

The Divisional Forest Officer, Saranda, is firmly convinced of the efficacy of cutting climbers during the rains in conversion working circle coupes. After two years of persistent cutting few are left on the area.

## BOMBAY.

### I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

There were only six subjects under investigation under the control of the Chief Conservator's office, while some subjects of local interest were taken up for investigation by the territorial Divisional Forest Officers.

(ii) *Natural Regeneration.*

*Evergreen forest.*

The three plots laid out last year in the sub-tropical evergreen forest at Bhimashankar in the Poona division, with the object of studying the effect on regeneration of (1) removal of undergrowth only and (2) removal of undergrowth and opening of the canopy, were maintained, but it is too early yet to record any results.

(iii) *Artificial Regeneration.*

*Hirda (Terminalia chebula).*

*Subject No. 37.*—Sowing and planting of *hirda* on laterite soil in the shade of existing shrubs or small trees (Poona and Satara divisions).

Two new plots were selected in the Budhele catchment area in the Poona division. In plot I, *hirda* seed was sown in 100 pits, 3 seeds in each pit, and the sowing had to be repeated as the seed originally sown was eaten by white ants. In plot II, 100 transplants were put out. Weedings were carried out in July and September. Survivals to the end of January 1938 were 15 seedlings in plot No. I and 60 transplants in No. II.

In the Mahaheshwar range (Satara division), *hirda* seed was sown in 100 pits,—2 seeds in each pit,—during the rains of 1937. 28 seeds germinated out of which 21 were surviving in March 1938, the average height of the seedlings being 2 inches.

*Cassia siamea.*

Last year's attempt at introducing *Cassia siamea* on the sites of deserted cultivation in the Tansa catchment area in the East Thana division, was fairly successful. The plants have grown to an average height of about 6 feet and the grass is almost suppressed. Only one weeding was required to be done in the 2nd year as a precaution against fire damage.

*Tung (Aleurites fordii).*

All the three surviving plants in the teak-pole coupe in Samhrani range and at Tatwal died during the year, probably due to excessive drought.

A nursery was made at Bomanhalli for further experiment of this species, the seed being sown 12" apart in raised unmanured beds. The sown seed was watered twice in the day both in the morning and evening. Out of 396 seeds sown, 77 germinated to the end of March,—germination having commenced from the 26th of February and continued till the end of October, by which time, 37 more seeds germinated bringing the total to 114.

The growth of these plants was very fast, and they were getting congested in their original beds. Accordingly 63 plants were carefully transplanted, 3' apart, in an extension of the present nursery on the 29th to 30th September 1937. In the original beds too, an endeavour was made to leave the existing plants spaced 3 feet apart, watering being continued for the 63 transplants only to assist them to establish themselves but they were not manured.

Out of the total of 114 that had germinated, 13 plants died between November and March without any ascribable reason. The surviving 101 are doing well, and height of the tallest plant is 71" while the average is 51".

*Chlorophora excelsa* (Uganda).

A quarter lb. of seed of *Chlorophora excelsa* (Uganda), received for trial from the Silviculturist, Dehra Dun, in August 1937, was tried in East Thana, East Nasik, West Nasik, North, East and West Khandesh and Kanara Northern and Eastern divisions, but was not successful.

except in Kanara N. D. where it was tested in four different localities, with the following results :—

Particulars.	LOCALITIES.			
	Kulgi.	Virnoli.	Sambrani.	Haliyal.
Date of sowing . . . .	16-8-37 and 30-8-37	10-9-37	28-8-37	31-8-37
No. of seeds sown . . .	500	548	1900	800
Date of germination . .	24-9-37	25-10-37	9-9-37	25-9-37
No. germinated . . . .	40	41	882	242
Germination percentages .	8%	7%	46%	30%
Maximum height . . . .	6"	3"	6"	7"
Condition of plants . . .	Healthy.	Fair.	Very healthy.	Healthy.

Seeds were sown in baskets and planted out in nursery beds when of suitable size ; transplanting will be done early in June.

(iv) *Tending—Thinnings and cleanings.*

Teak (*Tectona grandis*).

*Subject No. 34.*—Effect of different degrees of thinnings in teak plantations (Kanara N. D., E. D., and W. D.).

The next remeasurement is due in 1940-41.

*Subject No. 34-A.*—To determine the intensity of thinning most suitable for pure teak *rabs* at intervals laid down in the revised Thana working plan (West Thana division), i.e., at the 11th, 26th, 46th and 66th years.

Four plots (A, B, C and D) have been laid out in the West Thana division where the following treatments have been applied :—

Plot A—Unthinned (control).

Plot B—Thinned to " B " grade.

Plot C—Thinned to " C " grade.

Plot D—Thinned to " D " grade.

The thinnings were carried out in December 1937 after the initial measurements had been recorded. Remeasurements are to be taken every fifth year.

*Subject No. 34-B.*—To ascertain rate of growth of teak in plantations under different spacings (Dangs, Surat).

Two sets of 8 plots each, one in North Dangs and the other in South Dangs, are under observation for studying the rate of growth in teak plantations thinned to different espacements. The plantations when the plots were formed (in 1935) were 7 years old. The plots were thinned in January 1935 as below :—

Plots 1 and 5—6'×6' (control).

Plots 2 and 6—9'×9'.

Plots 3 and 7—12'×12'.

Plots 4 and 8—15'×15'.

The first remeasurement in these plots was taken in January 1938 and the results are given below :—

*Average annual increment per tree.*

Plots.	1 and 5.	2 and 6.	3 and 7.	4 and 8.
North Dangs (Dagdamba) . . .	.58"	.76"	1.37"	1.41"
South Dangs (Waghai) . . .	.52"	.78"	1.29"	.70"

The percentage of girth increment for the several plots is as follows :—

Per cent.

Plots 1 and 5—21.72.

Plots 2 and 6—28.72.

Plots 3 and 7—39.97.

Plots 4 and 8—22.90.

The above figures indicate that an average spacing of 12'×12' is more advantageous than that of 6'×6' or 9'×9' or 15'×15', in early years so far as girth increment is concerned.

*Plots Nos. 11, 12 and 13, Narayanpur Block, Navapur Range, West Khandesh Division.*

These plots were laid out in April 1928 and remeasured in March 1933 and May 1938. Plot No. 11 was kept untouched, plot No. 12 was given an improvement felling at the time of formation, and plot No. 13 was clearfelled and patches of teak plantation were made during the succeeding monsoon.

During the 10 years the plots have been kept under observation, 33 teak have come up into the 6"-12" class in plot No. 11,—29 prior to 1933 and 4 between 1933 and 1938. In plot No. 12 only 11 teak came up into this class in the first 5 years to 1933 while none came up into the class between 1933 to 1938. It therefore seems that the improvement felling in plot No. 12 fulfilled its function in so far as it concentrated increment upon the larger stems without dissipating soil fertility in producing regeneration. The number of teak removed in the improvement felling in 1928 from this plot was 86. How far a heavier felling would have succeeded in putting on greater increment in the larger girth classes cannot be known nor how serious is the suppression which has evidently occurred in the smaller girth classes. Plot No. 13 has been left untouched since its plantation patches were formed and has suffered severely from frost, probably due to the unhealthy condition of the plants in consequence of their congested state. Drastic treatment is necessary here.

### *Acacia arabica.*

#### *Plots Nos. 1 and 2 at Pimpalgaon in Dhond Range, Poona Division.*

These  $\frac{1}{4}$ -acre plots were laid out in 1927-28 and the trees were re-measured in 1931-32 and 1937-38. The crops in both plots were 21 years old at the time the plots were laid out and had received no interim treatment except that dead and fallen trees had been removed from time to time. Plot No. 1 was kept untouched as a control for plot No. 2, which was thinned by removal of 24 trees, i.e., 45 per cent. of the crop. The average girth at breast height of the former was 21.4 inches, while the average girth of the latter was 23.8 inches. After 10 years 13 trees have died or been removed from plot No. 1, leaving 52 trees with average girth of 28.5 inches; while the 27 trees remaining in plot No. 2 average 32.06 inches. Both plots will be felled during the year 1938-39 and the total outturn from each in branchwood and stemwood will be accurately measured.

#### *Plots Nos. 3 and 4 at Pimpalgaon in Dhond Range, Poona Division.*

These plots were laid out in February 1929 and re-measured in November 1931 and December 1937. They are similar to plots Nos. 1 and 2 except that the crops were only 15 years old when the plots were formed and that the two plots were not initially truly comparable.

#### *Plot No. 7 at Kangaon, Dhond Range, Poona Division.*

This plot ( $\frac{1}{4}$ -acre) was formed in March 1929 when the crop was 5 years old. The object of the plot was originally to ascertain whether

*babul* (*Acacia arabica*) of a suitable size for fuel could be produced in a shorter period than 40 years. The plot was "mechanically" thinned at the time of formation leaving 185 trees in the plot. In 1930 the object was altered as the original object had already been answered in the affirmative by study of similar adjoining crops. Accordingly, the plot was divided into 2 halves, the one being left as thinned already and the other thinned much more heavily to a spacing approximately equal to the crop height. Measurements were taken again in 1933 and a little further thinning done in both halves of the plots. In December 1937 measurements were again taken and a much more drastic thinning carried out, still keeping the first half much denser, than the second, retaining 43 and 25 trees respectively.

#### *Miscellaneous species.*

*Subject No. 16.*—Effect of improvement fellings on diameter growth (Dangs, Surat).

The plots were maintained and their next measurements are due in December 1939.

#### *Evergreen forest.*

*Plot No. 24*—Bombay sub-tropical evergreen forest, Mahableshwar (Satara).

This is a 2-acres plot (formed in January 1933) divided into 4 sub-plots. One was kept untouched as a control and the remaining three sub-plots were given selection fellings of varying intensity to study the results in yield and regeneration over a period of years. The first quinquennial measurements taken in January 1938, give some interesting results, for regeneration in sub-plot 1 has been much less satisfactory than in sub-plots 2 and 3 under much heavier felling.

#### (v) *Miscellaneous.*

Sandal (*Santalum album*).

*Subject No. 7.*—Annual girth increment of sandal (Belgaum and Dharwar-Bijapur divisions).

The triennial measurement of girth in plots 7AI to 7AIV was carried out in May 1937.

The average girth increment per tree per annum for the whole plot from the date of formation up to the last date of measurement is given in the following statement :—

Plot No.	Girth increment in inches per tree per annum.			
	1928.	1931.	1934.	1937.
7AI . . . . .	·20	·11	·14	·09
7AII . . . . .	·18	·13	·11	·07
7AIII . . . . .	·23	·22	·19	·09
7AIV . . . . .	·19	·13	·10	·07

(N.B.—Only those trees registering an increase in girth have been taken into account in arriving at the increment figures.)

*Subject No. 32.*—Correlation existing between the outer girth increment and heartwood increment of sandal (Dharwar-Bijapur division).

The next measurements and borings are due in 1938-39.

*Evergreen forest* (Bombay sub-tropical evergreen).

*Plot No. 20—Mahableshwar (Satara).*

The plot was originally formed in 1932 in quality I forest to study the effect of coppicing at different height from ground level. This investigation has been completed. The plot provides an interesting contrast to the surrounding area which was worked under the old plan at the same time as this was made a "type" felling for the new plan, the felling for the old plan being much more drastic.

*Plots Nos. 21, 22 and 23 (1-acre each), Mahableshwar (Satara),* formed about the same time are parallel plots to No. 20 but in Quality II, III and IV types of forest. Their second measurements were taken in January 1938.

*Sheep grazing.*

*Plots Nos. 28 and 29—Bhamburda, Poona Division* (South Indian Dry mixed deciduous forest).

Two 1-acre plots were formed in September 1936 to study the effect of sheep grazing in open forests of this type. After enumeration of all stock of tree species the area was handed over to the Agricultural Department for their sheep breeding experiments.

*Phenological observations on teak.*

These were continued during the year on sets of 5 trees in each of the Panch-Mahals, North Thana, North, East and West Khandesh and Kanara Northern divisions, and copies of records sent to the Central Silviculturist.

*Enterolobium timboua* Mart.

Last year's survival at Mahahleshwar is flourishing and has attained a height of 2'-8".

*Fire protection.*

In order to reduce the fire hazard in clear felled coupes where grass grows in profusion, the Divisional Forest Officer, East Thana, got a 5 feet ring cleared round promising groups of teak coppice in one and two year old coupes. The result is stated to be very satisfactory as the teak coppice shoots have not suffered any appreciable damage from fire and are growing vigorously.

## II.—WORKING PLANS.

The following working plans were sanctioned during the year:—

1. Revised working plan for the Nasik Above-ghat Forests.
2. Working plan for the Castle Rock Fuel Supply, Kanara N. D.
3. Revised working plan for Yellapur-Mundgod Teak High Forests, Kanara, E. D.

## CENTRAL PROVINCES AND BERAR.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

As experience is gained, it is becoming more and more evident that variations in the quality and composition of the Central Provinces forests and in the climatic and economic conditions are so great and change with such frequency that the standard systems of management, adopted so far, have failed to give the most satisfactory results.

Thus, for the Betul teak forests, prescriptions have been evolved which aim at treating each type of forest according to its special requirements and peculiar local conditions. In the more or less level plateaux on the hill-tops carrying an open, bamboo-less teak forest with much grass, it is considered advisable to retain the best poles at the time of

final fellings. On the hill slopes carrying a scattered overwood of mature or over-mature trees, with a dense underwood of bamboos suppressing abundant teak reproduction, all growth including advance reproduction and bamboos is being clear-felled, to allow the teak coppice to grow vigorously and thus overtop the bamboo regrowth. The open teak forests of the plains which are devoid of bamboos, contain scanty reproduction, and are liable to damage from frost, are worked under conservative improvement fellings under which only mature and over-mature trees are to be removed and congested woods are to be thinned out.

The following general observations in experimental plots and forests are of interest :—

In Balaghat, species such as *Terminalia tomentosa*, *Eugenia jambolana*, *Terminalia chebula*, etc., which are believed to minimize frost damage are being encouraged in opened up *sal* forests in frost-labile localities. In Nimar, frost continues to be the most important factor threatening regeneration. In Raipur, it is generally recognised that rainfall is just sufficient to support the growth of *sal* in its extreme western limit. Conservation of all the available soil-moisture, by avoiding undue gaps in the leaf canopy is considered desirable. Clear-fellings in such forests have therefore been replaced by a gradual removal of the overwood, and the results obtained so far have been gratifying.

(ii) *Natural regeneration including coppice and root suckers.*

*North Chanda.*—The object of E. P. 3 (1926) is to see if reproduction of teak can be induced in a thinned teak high forest infested with bamboos by (A) annual cutting (December) and burning (April) of bamboos; or by (B) fire protection. The only conclusion that can be drawn from enumeration of stocked squares, assuming that the sub-plots were initially comparable, of which there is no evidence, is that some seedling reproduction has been induced as a result of both the treatments. Between the two treatments, however, there is no marked difference.

*Betul.*—The object of E. P. 12 (1931 and 1937) is to find out the best method of obtaining natural regeneration of teak in a bamboo-less teak forest. Five sub-plots were formed in 1931 and treated as under :—

- A. No grazing, annual burning.
- B. Grazed, annually burnt.
- C. No grazing, contour trenched at 6' interval.
- D. Grazed, trenched as C.
- E. Untreated.

No reliable data regarding initial comparability or progress of regeneration since 1931 were maintained. Observation in 1937 showed that reproduction had not come up to any appreciable extent in any of the plots, and this paucity of regeneration appeared to be chiefly due to a dense overwood, which was, therefore, thinned out.

The following observations are reported from divisions :—

*Balaghat*.—There is no difficulty in obtaining natural regeneration of *sal* in localities where grass can be kept down by successful fire protection extending over several years, and by light grazing or grass cutting. Coppice regrowth is vigorous everywhere but in some places it is liable to attacks by gall insects which tend to prevent straight growth.

*Bhandara*.—It is noticed that in the mixed forests, fellings done towards the end of the hot weather are harmful as many stumps are killed due to the separation of the living bark from the wood.

*Bilaspur*.—Seeding of teak was unsatisfactory in North Raipur. Coppice regeneration of the important species was satisfactory in the worked coupes, but damage due to browsing by wild animals and to some extent by frost and accidental fires was noticed in some places.

*Mandla*.—To induce natural regeneration of *sal* in the Banjar forest local experiments were laid out as under :—

- (i) Two plots, one acre each, were selected. The overwood was heavily thinned out. One plot was fenced and the other left unfenced. Both were weeded in July and November. The resulting regeneration in both is excellent but the shoots in the unfenced plot have been badly eaten by *chital*. It is generally the large shoots, that are damaged; the small whippy ones are left practically untouched.
- (ii) In compartment 637, a plot of  $2\frac{1}{2}$  acres with *sal* coppice shoots was fenced (cost Rs. 80) and weeded, with the result that the shoots are coming straight up. The neighbourhood of this plot has also been weeded with very good results, but some of the shoots have been damaged by deer.
- (iii) An area of two acres was clear felled, burnt and planted up with *sal* seedlings and fenced. The clear-felling and burning have proved a complete failure, all the seedlings having died back. (The cost was Rs. 38.)
- (iv) In 1936, five acres were clear felled and fenced. Frost has killed back the seedlings two years running, in spite of the fact that damaged shoots were cut back each year. This and the previous experiments go to show that clear felling must be abandoned once and for all.

**Nagpur-Wardha.**—Trials made to induce root-suckers from *Terminalia tomentosa* by digging 1' deep circular trenches round the trees and 7' away from the trunk proved a complete failure.

**Nimar.**—*Hardwickia binata* regenerates well both from seed and coppice but is grazed with avidity. *Anogeissus latifolia* is similarly damaged, but whereas the former is hardy enough to withstand grazing the latter is being gradually eliminated.

**North Chanda.**—Regeneration of *Pterocarpus marsupium* is very scanty even in areas with a large proportion of mature trees. The coppice regrowth of teak however is very rapid (40' high, and 20" in girth in 10 years), especially from small-sized stumps.

**Raipur.**—Clearfelled areas in the *sal* working circle have been well-stocked with coppice shoots but the hulk of these though superficially well-shaped are unsound due to frost attack and will not produce holes which could be cut into sleepers. These will however admirably serve the purpose of a shelterwood which will enable the natural regeneration that is struggling underneath to develop without getting frosted.

**Saugor.**—Coppice regrowth of *Anogeissus pendula* in the Ramna reserve is not very promising.

### (iii) Seeds.

**Seed supply.**—The year under report was one of the poorest teak seed years on record and considerable difficulty was experienced in meeting the demand.

**Seed pre-treatment.**—To hasten germination of some of the obdurate species like *Poinciana regia*, certain *Cassias*, *Guaiacum officinale*, etc., the seeds were treated with concentrated sulphuric acid for 5 and 10 minutes, with good results.

### (iv) Nursery Work.

**Silviculturist's Experimental Forest.**—A small forest, in which is situated the 1 acre Ornamental Tree Nursery, has recently been placed at the disposal of the Silviculturist for experimental work. The following experiments have been started therein :—

(i) Heredity trials with solid *Dendrocalamus strictus* to see—

- (1) If seed from such culms produce solid culms.
- (2) If rhizomes from clumps with most of the culms solid, produce solid culms.

(ii) To find out if *Chlorophora excelsa* can be successfully grown in the forests of this province.

Some seed from Uganda, received from Silviculturist, Forest Research Institute, Dehra Dun, was tried at Chikalda, Pachmarhi, Supkhar and

**Nagpur.** At the first three centres the seed failed to germinate. At Nagpur 600 seeds were sown broad-cast on a prepared bed on 1st October. Germination commenced on 22nd October and was over by the 29th. Only 21 seeds germinated.

**Balaghat.**—A temporary nursery was made at Dhansua where 4,600 teak, 800 *Dalbergia latifolia* and 700 *Ougeinia dalbergioides* 'dona' (leaf cup) plants were raised at a cost of Rs. 32. In the Forest School nursery 15,000 'dona' plants of teak, *Dalbergia latifolia*, *Acacia catechu*, *Eucalyptus* spp., *Cassia siamea*, *Lagerstroemia flos-reginae*, *Anacardium occidentale* and *Artocarpus integrifolia* were raised. A number of these were sold and some given away free for Coronation planting, etc., and the total revenue from the nursery was Rs. 400.

**Bilaspur.**—Numerous plants were raised at the Deopur nursery, mostly in beds for stumps, and some in "donas". The species were teak, *Dalbergia sissoo*, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Gmelina arborea*, *Ougeinia dalbergioides*, *Cleistanthus collinus*, Bamboo, and *Cassia* spp.

**North Chanda.**—Nurseries at Ghantachowki, Moharli and Rambagh supplied all the stumps required for new plantations and replacement of casualties. The root system of most of the pricked out seedlings gets deformed and consequently they do not make good stumps. Pricking out is therefore to be discontinued.

**Saugor.**—Seeds of teak from Nilamhur, Allapilli, Bori and Ramna forests (one maund of each), *Pongamia glabra*, *Cassia siamea* and *Eucalyptus citriodora* were sown broad-cast in separate lots in the Ramna nursery with the following results. Germination of teak seed from outside was on an average 50 per cent. (Nilamhur poorest and Bori the best); *Pongamia glabra* 60 per cent.; *Cassia siamea* in donas, 80 per cent. and *Eucalyptus citriodora* in donas, 40 per cent.

**Yeotmal.**—From the Umerda nursery 200 seedlings of *Dendrocalamus strictus* were transplanted over an area of 85 acres, in pits, at a total cost of Rs. 18, in June 1937. About 62 per cent. plants survived. These were mulched in the hot weather. Plants put out on sloping ground and under shade were more vigorous.

Besides, small nurseries were maintained in several divisions.

#### (v) Artificial regeneration including agri-silviculture.

##### (a) Plantations.

The important plantations made during the year are detailed below :—

**Balaghat.**—7 acres of mixed forest were clear-felled and planted up, 12' × 12', with a mixture of teak, *Dalbergia latifolia* and *Ougeinia dalbergioides* 'dona' (leaf cup) plants in prepared pits, 6" × 6". The plants are

reported to be doing well. 5 acres of forest containing *Bambusa arundinacea* were clear-felled and planted up with teak and *Dalbergia latifolia* 'dona' plants. Plants were weeded in the cold weather. Total cost of formation was Rs. 25.

5 $\frac{3}{4}$  acres of the school forest were clear-felled, staked 6'6"  $\times$  6'6", and planted in July by the students with teak 'donas' (1,430), teak one-year stumps (1,430), *Dalbergia sissoo* 'donas' (575), *Cassia siamea* 'donas' (1,155) and bamboo seedlings (1,160).

*Bilaspur*.—23 acres were clear-felled in January 1937, felling débris (no bamboos) spread and burnt in May. 6,700 one-year old teak stumps put out 12'  $\times$  12' in the third week of June. Results have been fair with average height, in March, 11'2"—maximum 39".

21 acres of Central Provinces III quality mixed forest with scattered teak were clear-felled in January 1937, and debris including bamboos spread and burnt in May. 6,150 three-months old and 6" high teak 'dona' plants were put out 12'  $\times$  12' on 22nd and 23rd June. Weeding was carried out as necessary and casualties were replaced; results have been good, average height in March 1938 being 30"—maximum 92".

A small experimental plantation was made with *Dalbergia sissoo* and *Dalbergia latifolia* 'dona' plants on sandy soil with almost no tree growth. Results have been good for *sissoo*, average height 10'9"—maximum 30" but not very satisfactory for *Dalbergia latifolia*, the average height being 6"—maximum 16".

In Tenduchua felling series, 4,450 teak stumps from one-year old seedlings were put out, 12'  $\times$  12', towards the end of June and weeded as necessary. In March the average height was 10'3" and maximum 47".

The cost of formation amounted to about Rs. 5 per acre, which is much less than at Nilamhur.

*Mandla*.—In 2 acres of a blank area in *sal* forests *sal* seedlings are reported to have been transplanted and fenced.

*North Chanda*.—10 acres were clear-felled and debris burnt in May 1937. One chain wide strips were planted 9'  $\times$  9', with stumps of teak, *Pterocarpus marsupium*, *Albizia lebbek*, *Chloroxylon swietenia*, *Lagerstroemia parviflora*, *Clietanthus collinus*, *Dalbergia sissoo*, *Morus alba*, etc., in July. The area was weeded twice when casualties were replaced. *Lagerstroemia*, *Clietanthus* and *sissoo* failed, but others are doing well.

*Saugor*.—*Pongamia glabra* seed was sown in 2,475 pits and nearly 14,000 teak stumps, 270 *Eucalyptus* and *Cassia siamea*, and 170 other seedlings were put out in suitable places over the entire coupe in July 1937. The result was a complete failure which is attributed to the growth of rank grass.

*South Chanda*.—303 acres were planted, 12'×12', with about 86,000 stumps and 22,500 seedlings of teak, after clear felling, exploitation and burning at a cost of Rs. 1,350. Eradication of *Mucuna prurita* and weedings were carried out in October and December.

Small plantations are being made annually in several divisions. Failures reported from several centres appear to be chiefly due to the unsuitability of the locality or faulty technique.

*Pollinidium angustifolium* Plantation (*sabai grass*).—Experimental plantations are being made in Betul and Chhindwara.

#### (b) Agri-silviculture.

Very successful agri-silvicultural work is reported from Yeotmal. The agri-silvicultural work done during 1937-38 is detailed below :—

*Amraoti*.—69 acres of *babul bans* were under regeneration at the commencement of the year and another 71 acres were taken up during the year. *Santalum album* seed was dibbled under 60 bushes of *Zizyphus jujuba*, *Zizyphus xylopyra* and *Gymnosporia montana*; results were disappointing. Sandal seed was also sown in the Mehadari forest, 30 per cent. of which germinated.

*Melghat*.—The coffee plants are growing satisfactorily in areas leased out to the Roman Catholic Mission. Some areas covered with *Lantana* were given out to forest villagers for a period of three years for cultivation, on condition that they would plant cuttings of various forest trees between the lines of field crops. As far as the eradication of *Lantana* goes the method has been a great success but planting work has been neglected.

*West Berar*.—Teak sown in all the three localities failed completely probably due to very late (July) sowings. Other species tried were *Acacia arabica*, *Gmelina arborea*, *Albizia lebbek*, *Pongamia glabra*, *Anogeissus latifolia* and *Dalbergia latifolia*. All germinated satisfactorily except *Anogeissus*. *Azadirachta* was badly browsed as also *Gmelina*, *Albizia* and *Dalbergia* to some extent.

*Yeotmal*.—23,000 teak stumps and 3,000 seedlings were put out in gaps in plots 1 to 9 at Pandhardevi. The plots are now fully stocked. Teak occurring in *Acacia catechu* lines was freed, and *Acacia arabica* heavily thinned and pruned.

Half acre patches in each of the 18 plots at Borwadi were clear-felled in April, burnt in May and thoroughly cross-ploughed soon after. One-year old teak seed, which had been left in white ant nests for a month was sown on 31st May. Germination commenced in the first week of July and progressed satisfactorily. Gaps in the lines were filled up by transplanting superfluous seedlings from the previous year's plots. A

total area of 27 acres has thus been successfully regenerated in the last three years.

Agri-silvicultural work at this centre was commenced in 1925, and the experience gained at this centre is summarised below :—

Agri-silvicultural work should be undertaken only in localities where land-hunger is intense and cheap labour is readily available. The soil should be fairly rich and well-drained so as to yield a good harvest and eventually a good forest of at least Central Provinces IVa—quality. Cultivators should not be given more than 10 acres apiece. As a large outlay is involved in clearing the site and for subsequent weeding operations, fairly well-to-do tenants prove more successful than poorer ones. It is necessary to cross-plough the land in order to remove root stocks of trees and other herbage as this is not possible after the tree species have been introduced. Therefore during the first two or three years of the lease the cultivators should be allowed to grow only field crops. The obnoxious perennial grass *Ischaemum pilosum* can thus be completely exterminated. Forest species should be introduced in the third or fourth year and tended during subsequent years.

By far the most suitable species for the better soils is teak and *Acacia catechu* for the comparatively poor soils. Teak can be easily introduced as stumps from one year old seedlings. A nursery of about 1 acre for 500 acres to be planted up is enough and should be started in the third year of the lease to get stumps ready in the fourth year. But should it be found more convenient to grow a crop by direct sowings, teak seeds kept in white ant nests for a year after collection should be used as these germinate readily when sown thickly in lines a few days before the monsoon sets in.

Germination of the seed is not very good in the first year, but if the seed is left undisturbed much of it germinates in the second year. *Acacia catechu* seed should be sown after the rains have well set in. Germination is as a rule good and replacement of casualties is not necessary.

61 acres of fairly well stocked mixed forest of Central Provinces IVa to III quality was clear-felled at Kinwat in January 1937. The cut material was collected in small heaps on the big stumps in February and burnt in April-May. The soil was thoroughly cross-ploughed and harrowed. Weathered teak seed was sown in lines 6' apart towards the end of May. Two lines of cotton seed were sown between the teak lines. The plots were weeded in August, September and October. These operations have cost nothing to the department and in fact yielded a small profit.

The *rab-cum-taungya* method of restocking described above is proving very successful and may with advantage be tried in other divisions where agri-silvicultural work is in progress.

(vi) *Reclamation, afforestation and arboriculture.*

*Reclamation.*—In the *Pinus longifolia* plantations, at Supkhar, in which *sal* roots were not grubbed out at the time of formation, the overhead cover of the conifer is helping the *sal* saplings to establish themselves indicating that heavy shade does act as a successful frost-screen.

Of other areas open to reclamation, extensive blanks in *sal* forests are gradually being stocked by root suckers of *Diospyros melanoxylon*, and the numerous hills in Berar which have become bare as the result of heavy grazing.

*Afforestation.*—Several areas along the main rivers of the province are gradually getting denuded due to gully-erosion. The scrub jungle forming part of the catchment area of the Telinkheri lake in Nagpur is being placed in charge of the Silviculturist for afforestation with more suitable species.

*Arboriculture.*—Arboricultural work is primarily the concern of the Agricultural Department. The part played by the Forest Department only consists of propaganda to make the public conscious of the necessity for a picturesque environment for its general well being, and to afford the necessary facilities to attain this—in other words, to make the people tree-minded.

The Silviculturist has started a small nursery at Nagpur, where suitable plants of ornamental, flowering and shade trees, indigenous as well as exotic, are being raised and offered for sale at cost price.

(vii) *Tending.*

(a) *Thinnings in young teak—a suggestion.*

The coppice regrowth of teak in clear-felled areas is extremely irregular. Variation in size is primarily due to the varying vigour of the parent stools of seedlings, saplings, poles, mature and overmature trees. Grade-thinnings, which have crown classification as their basis, are impracticable. Similarly the extremely varied nature of the crop precludes the possibility of purely mechanical thinnings.

A new method of thinning has been worked out to suit these types of forest. It is based on what are known as *Freidurch-forstung* (Free thinnings), or to use a more expressive phrase, *individual stem silviculture*. It is applicable to any young teak forest without regard to its quality, age or stocking density, although the ultimate aim is to obtain a uniform mature crop.

It should be possible to find out, roughly (by reference to any suitable yield table if available, or by personal experience) how many uniformly

spaced *elite* stems should be left at the first thinning so that when properly tended they will yield the requisite number of trees at maturity. It will be found that this number will generally be between  $3N$  and  $4N$  for the low forests and between  $4N'$  and  $8N'$  for the high forests where  $N$  &  $N'$  represent the numbers at maturity.

Having obtained a rough idea of the number of *elite* stems the (approximate) average diameter of the trees of the top-height class, i.e., the predominant and codominant trees as adjudged from their heights compared with those of the neighbouring trees should also be determined. The number of *elite* stems to be retained for this average diameter should next be estimated by observations or checked against a suitable yield table. The double check will give a fairly accurate idea of the number of *elite* stems to be retained at the first thinning. From the number thus obtained the average espacement should be worked out from the formula\*,  $d^2 = \frac{2}{3} \frac{A}{N}$ , where  $d$  is the distance between adjacent trees,  $A$  is the area and  $N$  is the number of stems. Once the value of  $d$  is obtained in this manner, the thinning operations become more or less mechanical.

Observations made so far justify the following tentative conclusions :—

Species of climbers.	Success under above treatments.			Remarks.
	(i)	(ii)	(iii)	
<i>Acacia caesia</i> & <i>A. pennata</i>	Nearly 100%	..	..	In North and South Chanda.
<i>Bauhinia vahlii</i> . . .	nil	Partial	Slightly better.	When climber is very thick much deeper digging required.
<i>Butea superba</i> . . .	75%	90%	..	In North Chanda.
<i>Calycopteris floribunda</i> .	95%	100% (90%)	..	Do. (In South Chanda.)
<i>Combretum decandrum</i> .	..	100%	..	In South Chanda.
<i>Cryptolepis buchanani</i> .	..	Nearly 60%	..	Do.
<i>Milletia auriculata</i> . . .	..	100%	..	Do.
<i>Zizyphus oenophia</i> (a thorny shrub).	..	100%	..	Do.

\* or  $d^2 = 50, 312/N$  (approximately) where  $d$  gives the distance in feet. The formula assumes that the trees are situated at the vertices of equilateral triangles which is a better approximation to natural conditions than the assumption that trees occur at the corners of squares.

## (b) Climbers and Weeds.

**Climbers.**—The five-year climber cutting programme prescribed in many plans has not been found satisfactory as whenever the cover is open this results in the climber growing with greater vigour after cutting. Attempts are therefore being made to discover a more effective and yet inexpensive method of eradicating the most destructive climbers or at any rate keeping them in check. Experiments are being conducted in several divisions. Experience gained up-to-date is summarised below :

The most destructive climbers are :—

*Acacia caesia*, *Acacia pennata*, *Bauhinia vahlii*, *Butea superba*, *Calycopteris floribunda*, *Combretum decandrum*, *Cryptolepis buchanani*, *Milletia auriculata*, *Mucuna prurita* and *Zizyphus oenoplia*.

The effects of three treatments have been studied, viz.—

- (i) Cutting 6" below ground level and covering loosely with earth.
- (ii) Cutting as under (i), but ramming earth firmly over the stump.
- (iii) Cutting as above, smearing the cut surface with kerosine and tar and then firmly ramming earth over the stump.

The following are only tentative conclusions and the experiments are being continued to obtain conclusive results. So far, treatment (i) kills only a few species, whereas (ii) gives extremely satisfactory results. There is practically no difference in the cost under these two treatments, but (iii) is definitely more expensive.

A feature of the year was the excellent climber cutting work done by forest guards while patrolling their beats.

**Weeds (*Lantana aculeata*).**—In accordance with the prescriptions of the Melghat working plan, *Lantana* was pulled out in the rains of 1935 and 1936 with the help of elephants in coupes I & II at a cost of as. 12 per acre. In 1937, *Lantana* was first burnt and then uprooted with the help of elephants, at a considerably lower cost of as. 6 per acre. But subsequent observations show that such treatment is not only an expensive operation but it also does not exterminate the pest, which reappears soon after with sufficient vigour to retard seedling reproduction. On the other hand it is observed that *Lantana* has almost completely disappeared from fire lines as a result of successive burns.

## (viii) Mixtures.

Increasing attention is being paid to the retention of miscellaneous, soil-sheltering species in teak plantations. *Dalbergia latifolia* and *Ougeinia dalbergioides* are so utilised in Balaghat. In Bilaspur, trials

have been made with *Dalbergia latifolia*, *Pterocarpus marsupium*, *Gmelina arborea*, and *Swietenia mahagoni* but the results have been somewhat disappointing. The failure of these species is chiefly attributed to their slow growth and susceptibility to browsing. Better results are likely to be obtained by increasing the espacement of teak from 6'×6' to 12'×12' and thus allowing sufficient space for the coppice regrowth, which is comparatively fast growing, to become established. Suitable species from among this miscellaneous regrowth could then be favoured in subsequent cleanings to obtain a desired mixture. The common bamboo (*Dendrocalamus strictus*) can grow under the shade of teak, is readily saleable, and is capable of growing into a soil-sheltering understorey. Trials have shown that this can be introduced by patch sowings and attempts are therefore being made to extend these operations.

#### (ix) *Underplanting.*

Experimental planting of teak and other species under a complete canopy of mixed forest was carried out over an area of four acres in the North Chanda division for the third year in succession. Observations in 1935 and 1936 plantations show that naturally the plants under shade are weak and lanky as compared with those in the open but the survival percentage is very high and the plants retain their leaves longer. Any deductions at this stage would be premature.

#### (x) *Silvicultural systems.*

In *Amraoti*, opinions seem to be divided as to whether understocked areas, containing teak or other species, should be subjected to improvement fellings, or to clear-felling and subsequent replacement.

In *Bilaspur*, experimental clear-fellings in *sal* regeneration areas show that such operations are unsafe as frost is a serious factor to be contended with. Retention of a shelterwood is therefore advocated. The extent of cover retained will depend upon the susceptibility of the area to frost. 90 to 120 trees per acre ranging in girth from 1' to 3' are found to afford ample cover in average localities.

In *Hoshangabad*, the shelterwood system of regeneration is being replaced in frost liable areas by improvement fellings under which sufficient overwood is being left to provide protection against frost.

In *Melghat*, the teak forest taken up for conversion is too young and much young and middle aged growth is being sacrificed by adopting a short rotation of 60 years.

In *North Chanda*, the advance cutting of bamboos to prevent the suppression of teak coppice after clear-fellings is silviculturally quite successful, though expensive. Established regeneration of *Pterocarpus marsupium* does not occur, and clear-fellings are resulting in the gradual

disappearance of this valuable species. As a safeguard, therefore, all sound trees up to 3' girth are being reserved. Experiments to introduce the species artificially are also being made.

In *Raipur sal* forests, which are seriously damaged annually by frost, the uniform system is hardly suitable: reservation of a shelter-wood to protect the young regeneration for a considerable time is indicated.

In *Saugor*, clear-fellings in the regeneration areas of the Ramna forest have been disastrous owing to severe frost damage to the young crop. The system of High Forest with Reserves under which a cover in the form of promising poles can be retained has therefore been prescribed. To save costs on subsequent weedings, advance planting in areas devoid of regeneration has also been resorted to.

#### (xi) *Miscellaneous.*

*Fires.*—Most of the fire lines in Balaghat are too narrow to stop a conflagration sweeping up a hill and there is little doubt that such fires take a heavy toll of *sal* reproduction and result in a retrogressive succession to a savannah type.

In Hoshangabad, to minimise damage from fires there is a growing tendency to admit grazing in regenerated areas as soon as the tree species have grown to a size when they cannot be damaged by cattle. In North Chanda division, the number of fires in recently regenerated crops has increased due perhaps to incendiarism.

*Frost.*—Mr. Harlow, Conservator of Forests, has recorded his impressions on the causes of frost damage and suggested certain remedies, in an article published in the *Indian Forester* for January 1937. The Provincial Silviculturist has also suggested in a small note (*Indian Forester*, 1937, pp. 578-79) a possible method of preventing frost damage by inducing the circulation of stagnant cold air by cutting a series of strips across frost-labile depressions, and running in the direction of the prevailing wind in the locality.

*Grazing : Experimental work.*—The grazing plots in Saugor and Yeotmal were maintained and the data from the latter were analysed by the Central Silviculturist, Dehra Dun. The analysis shows that the divergence in the yields under identical treatments is so great as to have completely swamped the effect due to treatment alone. It is not possible to deduce any reliable conclusions regarding the optimum grazing incidence or grazing-closure cycle. There have, however, been some definite observations of interest, viz. :—

- (i) *Cassia tora*, an invasive pest of the pastures can be suppressed after a year's closure and more or less completely exterminated after 2 or 3 years' closure.

- (ii) *Andropogon contortus* (Spear grass) which is disliked by cattle, can be gradually replaced by the palatable grass, *Ischaemum laxum* (*sheda*), by repeated closures.
- (iii) Heavily grazed pastures recover sufficiently after 2 or 3 years' closure and grass cuttings after the seed is shed, and that closures beyond 4 or 5 years instead of further improving the pasture actually lead to an increase of the coarser grasses like *Anthisteria ciliata* and *Apluda varia*.

New experiments are about to be laid out, in collaboration with the Agricultural Department to find out the best method of improving the 'Open Pastures', i.e., areas in which the primary demand is for grazing.

Forty acres of a permanent pasture land and 5 acres of a permanent grass reserve have been selected for the purpose and the preliminary investigation to assess the trend of variations in the locality has just been completed. The entire areas has been grid-surveyed, i.e., divided into one chain squares.

In Bilaspur, coupes of certain felling series were opened to grazing of cows for a part of the year to minimise fire-hazard, as also to help the regeneration to get through. The results were very gratifying.

## II.—WORKING PLANS AND STATISTICS.

### (i) Working Plans.

The (10-yearly) revision of the following working plans was completed during the year:—Yeotmal, North Raipur, Hoshangabad, Buldana and Seoni. Besides, the revision of the Chhindwara and Jubbulpore plans was also nearing completion towards the close of the year.

The plans of Old North Mandla, Raipur Mixed, North Chanda, Ahiri Leased Range and Melghat were published during the year. Many detailed amendments were issued to several of the current plans and the grazing settlements accompanying them to bring their prescriptions up-to-date, and to redress reasonable grievances of the agriculturists in regard to grazing and extraction of certain minor products.

### (ii) Statistical.

*Sample plots.*—Four new sample plots in young teak plantations were laid out during the year, thus bringing the total to 117. The sample plot data collected during the last twenty years were examined

with a view to find out if local yield tables for *sal* and teak could be compiled. It was found that this would not be possible for some time, as data for certain ages and qualities are still very meagre. Meanwhile, two graphs have been prepared for teak plots, one showing crop diameter and the other crop height against age.

*Experimental plots.*—Besides preliminary operations in the Nagpur pasture experiments, mentioned before, the only other important investigation started during the year was a detailed experiment in Nagpur-Wardha division to determine the best method of tapping *Sterculia urens* trees for their exudation known in trade as gum Kareya. 196 trees are being tapped at fortnightly intervals to study the effect on the production of gum of :—

1. 4 kinds of blazes, viz., (1) notches with axe or *chheni*, (2) horizontal or slanting slits, (3) oblong blazes and (4) triangular blazes.
2. Aspect.
3. Girth of trees.
4. Continuous tapping and tapping in alternate years.

Tapping commenced in October and was stopped in June. The figures of yield of gum have been sent to Dehra Dun for analysis. It was noticed that the gum is eaten with avidity by monkeys.

### III.—MISCELLANEOUS.

The office of the Silviculturist was held by Mr. K. P. Sagreiya, Deputy Conservator of Forests, throughout the year and he toured for 101 days. The post of the Assistant Silviculturist remained vacant.

A number of photographs were added to the collection during the year. All important publications were ledger-filed by cross references or insertions of cuttings. A manuscript catalogue for the provincial forest library is nearing completion.

## COORG.

### I.—EXPERIMENTAL SILVICULTURE.

#### *Seeds.*

*Germination test of Santalum album.*—Seeds with pulp and without pulp were sown in nursery beds in the 3rd week of May 1937; the latter

germinated much more than the former, their corresponding percentages of germination being 71 and 23 respectively. This corroborates the previous year's results.

Now it is the practice in Coorg to remove the pulp of seeds before sowing in all sandal regeneration operations.

*Germination test of evergreen species.*—Seeds of *Hopea parviflora*, *Cedrela toona* and *Dysoxylum malabaricum*, sown in nursery beds at Makut, failed to germinate owing to unfavourable weather conditions. Flowering and fruiting of evergreen species was generally bad during the year.

*Sagera.*—Of the seed received from Dehra Dun the first 200, sown in nursery beds at Makut on 22nd June 1937, proved a complete failure. A second lot of 100 seeds were again sown on 4th January 1938 and the bed was watered daily. On 7th March 1938 four seeds only germinated, but the seedlings died immediately after.

*Oil palm (Elæis guineensis).*—310 seeds were sown on 2nd March 1937 at an espacement of 6"×6" in the nursery at Makut. Germination commenced on 3rd May 1937, and was 68 per cent. by 5th July 1937. Germinating seeds were transferred to nursery beds where they were planted at an espacement of 12"×15", and the seedlings came up well.

*Tung (Aleurites fordii and Aleurites montana).*—The results of germination for 1937 and 1938 are given below :—

Locality.	1937.				1938.			
	ALEURITES FORDII.		ALEURITES MONTANA.		ALEURITES FORDII.		ALEURITES MONTANA.	
	Seeds sown.	Germination.	Seeds sown.	Germination.	Seeds sown.	Germination.	Seeds sown.	Germination.
		Per cent.		Per cent.		Per cent.		Per cent.
Iygoor . .	836	58	532	69	1,000	55	1,000	38
Meenkolli . .	800	66	640	50	1,000	58	1,000	28
Ammale . .	576	64	288	50	1,000	40	1,000	13
Tittimatti . .	624	75	432	12	1,000	25	1,000	9
Irumani . .	408	66	288	29	..	..	..	..
Balecove . .	800	78	560	25	..	..	..	..
Nagerhole . .	..	..	..	..	1,000	62	1,000	33
TOTAL . .	4,044	68	2,740	40	5,000	43	5,000	24

Both in 1937 and 1938 the percentage of germination were better in the case of *Aleurites fordii* than *Aleurites montana*.

Germinating seeds were transferred to baskets and in all 3,854 basket plants were raised during the year. 1,533 basket plants were planted out in the field over 12 acres and 1,210 basket plants were supplied to outsiders.

### *Sandal regeneration experiments.*

*Propagation centres and individual basket fences.*—No new centres were opened during the year. 469 propagation centres and 674 basket fences of previous years were maintained. There are plants in most of the centres and the best plant measured 11' 6" in height and the minimum was about 12", the latter being mostly replacements during the year.

### *Artificial regeneration.*

Results obtained from 3 years' experiments carried out during 1935, 1936 and 1937 on pre-monsoon stump-planting at fortnightly intervals starting from the middle of April and continuing till the beginning of July have indicated so far that the best date for stump planting in Coorg lies between the 25th April and the 10th May. The survival and height growth of those plants put out on 15th April, 1st May and 15th May were decidedly better than those put out after 15th May—the superiority having been maintained in the 2nd and 3rd years also.

Experiments in Nagerhole and Devamachi where stumping and sowing were done at stakes on different dates indicate that early sowings have given a fair percentage of germination at stakes than those sown late in the year, the percentage varying from 52 to 10. The height growth of plants was also better in early sowings, but cannot be compared with plants raised by stumping where the survival percentage is much higher and the height growth is almost double.

The method of raising Teak plantations in Coorg has now changed from the old practice of sowing at stakes to early (pre-monsoon) stump planting.

*Effect of taungya (kumri) crops on the growth of teak in a plantation.*—The experiment in Devamachi 1936 area with cover crops of paddy, ragi (*Eleusine coracana*), dal (*Cajanus indicus*), and *Tephrosia* (with controls for each) was under observation. Details of percentage of survival and mean height at the end of the 2nd growing season indicate that in many cases the percentage of survival and mean height growth are better in the control. The height growth of plants in the plot kumried with ragi (*Eleusine coracana*) is poor,

This corroborates the previous year's results about the retarding effect of the field crop on teak.

*Best planting distance of teak and its effect on the height growth of teak plants.*—(a) Observations in experimental plots Nos. 27 and 35 in Nagerhole and Devsmachi 1935 areas were continued. Three espacements were introduced, i.e.,  $6' \times 6'$ ,  $4\frac{1}{2}' \times 4\frac{1}{2}'$  and  $3' \times 3'$ . As this experiment is a long term one, it is yet too early to offer any remarks.

(b) This year another experimental plot was opened in Devamachi 1938 regeneration area and the above three espacements were introduced. The area has been successfully stump planted with teak.

*Cover crop* : (a) *Tephrosia candida* (Boga) introduced in the 2nd year of a teak plantation (E. P. Nos. 24 and 51, Nagerhole and 28, Kalhalla).—These areas were dibbled with teak and *kumried* in the 1st year of formation and *Tephrosia* introduced in between teak in a quincunx manner in the second year. Casualties were not replaced. In all centres the growth of *Tephrosia* was good and these were cut back to allow teak to grow uninterrupted.

A careful scrutiny of the results obtained so far (including 1938 measurements) reveals that the percentage of survival in all cases is better in the control than in the *Tephrosia* strip. As regards development of plants it is noticed that the height growth of plants in *Tephrosia* strips is better in the experimental plots in 1934 areas, whereas in 1935 area the growth of plants is better in the control strip.

The plants in the *Tephrosia* strip are lanky and those in control are stout and slightly branchy. There is no *lantana* or other woody undergrowth in the *Tephrosia* strip and the floor is fairly clean.

It is indicated that if *Tephrosia* is introduced after giving a good start to teak it keeps down weedgrowth and maintains a fairly clean floor, and the teak plants are less branchy developing clean stems.

(b) *Tephrosia* was sown in grassy and non-grassy areas in the third year of a plantation to study its effect on grass and development of teak (E. P. No. 56, Nagerhole) :—

The results are as follows :—

Germination of *Tephrosia* was poor and the development of those successful was also not satisfactory. Hence it is difficult to draw any conclusion from this experiment.

*To compare the effect of the following on the development of teak in the first year of formation* :—(a) *Stumping and weeding* ; (b) *stumping and scraping* ; (c) *stumping and kumri with ragi* (*Eleusine coracana*) ; (d) *sowing and weeding* ; (e) *sowing and scraping* ; and (f) *sowing and kumri with ragi* (*Eleusine coracana*).—In the strips where weeding and scraping was done, no other treatment was carried out during the year,

In the bit *kumried* with *ragi* some backward plants were weeded and woody under-growth interfering with teak were cut down. Measurements of plants in the plot opened in Ammale 1936 area, Fraserpet Range, were recorded and abbreviated results are given below :—

Locality.	E. P. No.	Treatment.	Per cent. of survival.	Mean height in inches.	REMARKS.
Ammale 1936 area	45	Stumping and weeding.	96.4	83.93	After two growing seasons.
		Stumping and scraping.	95.5	105.44	
		Stumping and <i>kumri ragi</i> .	93.6	49.47	
		Sowing and weeding.	95.5	70.78	
		Sowing and scraping.	92.7	79.00	
		Sowing and <i>kumri ragi</i> .	92.7	12.61	

Stumping has given best results both in survival and height growth. The growth of plants in scraped strip is very good. Even in the strip sown the growth of plants in scraped bit is better than the other two. This indicates that stumping is good, and also that scraping in lines assists the development of plants to a great extent. Further it is observed that the *taungya* crop of *ragi* is found to retard the growth of young teak to a great extent.

*Effect of underplanting teak areas with Dalbergia latifolia* (E. P. Nos. 37 to 39, Mallipatna).—Observations in 1933, 1934 and 1935 areas were continued. About 60 per cent. of the plants are established and there are some natural plants also coming up well in these plots. The plants are whippy and the best one is 7' high ; they are now struggling in midst of teak which in some cases are more than 20 feet in height.

*Effect of burning and cutting back of teak plantation in the second year of formation.*—Experimental plot in Nagerhole 1935 area was under observation. Results of height growth indicate that burning or cutting back or both are, after two years, all inferior to no burn and no cutting back. The weed growth, however, is kept down by this early burning, thereby freeing teak seedlings in the early stage from competition.

*Teak stump origin experiment.*—Stumps prepared from seedlings raised from Nilambur and Mysore seed origins were planted in

Nagerhole 1935 area (E. P. No. 25). Results of plant measurements are analysed below :—

Year of formation.	Origin.	On 28th March 1937.		On 24th March 1938.	
		Per cent. of survival.	Mean height.	Per cent. of survival.	Mean height.
1935	Nilambur . . . .	87	68.37	86	125.26
	Mysore . . . .	78	47.91	80	89.86

The above shows that Nilambur stumps have given better results both in survival percentage as well as in height growth than stumps of Mysore origin.

*Teak seed origin experiment.*—Seeds of Coorg (local) and Mysore origins were sown on 24th April 1935 in the experimental plot (No. 24) in Nagerhole 1935 area. At the end of three growing seasons their relative survival percentages were 79 and 70 and mean heights 40" and 42" respectively without showing any significant difference so far between the two origins.

#### Miscellaneous.

*To study growth of sandal in plantations with teak as host.*—The stocking and growth of sandal in experiment No. 7 of 1934 in Tittimatti is good with an average height of 10 feet and girth of 8 inches. The plot was thinned during the year.

Sandal sample trees have been selected in all working centres of sandalwood tract and their girth measurements and condition were recorded. Old sample trees of sandal, teak and evergreen species are also being maintained.

*Dehra Dun (F. R. I.) sample plots.*—The Central Silviculturist with a sample plot party laid out, during November-December 1937, a number of plots (about 40) to study growth increment in teak, sandal and evergreen species, to determine the period and the best intensity of thinning teak plantations along with the botanical study (by the Forest Botanist) in case of linear plots in Makut Forests.

A sandal wood tree increment plot was opened at Meenkolli in older plantations to determine (i) the period sandal takes to reach the present exploitable size of 40" girth, (ii) the financial rotation and (iii) to find out when rot generally comes in and starts depreciating the value of the tree.

A linear plot 7 furlongs in length was laid out along Meenkolli road, one chain on either side, and 357 trees in this are under observation. The trees have been measured for girth, height and crown spread and the situation of each tree is also noted.

*Linear sample plots in evergreen forests.*—Two plots were laid out in Makut Range to determine (1) growth increment of evergreen species, (2) botanical identification and (3) the differences in types of forest for Working Plan purposes.

Trees 4" diameter and over at breast height were measured and 2,250 such trees in one plot and 1,685 in the other were numbered with zinc plates.

*Sandal spike disease.*—Some 387 attacked trees, noticed in different plantations or village sites were treated with Atlas and killed (and uprooted in a few cases).

*Sandal spike incidence in Hudgur 1928 plantation.*—Except for five incidences in August 1936 no fresh attack has occurred. The observation plot and sandal area in the vicinity are inspected periodically for spike attack and so far none could be found.

*Badabanalli sandal observation area of 1936.*—This experimental area was maintained during the year and in plot 6, 500 bamboo seedlings and 500 *Cassia siamea* plants were introduced in July 1937, only 105 of the former and 165 of the latter are now surviving. Regrowth of *Lantana* was completely uprooted in plot 4, and the area was successfully fire protected. In November 1937 twelve cases of spike were noticed in plot 4. All these trees come within a radius of 5 feet and they may be the sprouts of the same parent tree, most probably root suckers. All were promptly treated with Atlas. Besides, there were 44 incidences of spike in the adjoining sandal area and the trees were treated with Atlas and killed. This area is open to grazing and considerable damage is caused to sandal plants by village cattle.

From the results of enumeration, it is observed that there is considerable increase in the stocking of sandal. The stocking has increased slightly in the plot where *Lantana* was uprooted.

*Teak defoliation experimental areas in South Coorg.*—Periodical measurements of trees in these areas were recorded during the year. In Tittimatti, defoliation was noticed in all plantations and in some areas in a severe form. In Nagerhole, the defoliation was rather severe, but not so in Fraserpet and in the teak plantation at Makut.

*Gap regeneration in the Closed Working Circle (Nagerhole).*—Three spots, each 0.3 to 0.5 of an acre, were clear felled, burnt, the gaps were staked 6' x 6' and planted with teak stumps in the third week of April 1938.

*Tung cultivation (Aleurites fordii and Aleurites montana).*—Plantations have been opened in six localities. Results in respect of survival percentage and height-growth are quite encouraging so far. The plants were measured in June this year and the best plant (*A. montana*) in Iygoor was 7' 1" in height and *A. fordii* 5' 3". The plants are growing vigorously.

*Oil palm area (Elavis guineensis).*—An area of about two acres near Urti was clear felled, and rubbish burnt. Palm plants were planted in the 2nd week of July at an espacement of 20' × 20'. The area was *kumried* with hill paddy, casualties in palm were replaced and at the end of the year the survival was 51 per cent. The tallest plant is 12" high and the plants are not looking happy. They were shaded during the hot weather.

*Manurial demonstration on tung (Aleurites fordii and Aleurites montana).*—The object of this experiment is to ascertain the response in growth and yield from Sulphate of Ammonia, Concentrated superphosphate and Muriate of potash.

Eight plots were opened, four for *Aleurites fordii* and four for *A. montana* in Iygoor 1937 area. Four treatments were applied, one being the control. (Fertilisers were applied on 7th June 1938.)

*Regeneration work in evergreen (rain) forests.*—Experiments to study the survival, development and increase of natural regeneration of valuable species when tended according to prescriptions of the working plan, and secondly to watch the survival and development of artificially introduced valuable species such as *Hopea*, *Artocarpus*, etc., have been in progress and observations were continued during the year.

Sample strip enumerations indicated that regeneration of *Vateria indica*, *Hardwickia pinnata*, *Artocarpus hirsuta*, *Dipterocarpus indicus* and *Palaquium ellipticum* is found in abundance,—*Vateria* being the predominant species. As regards artificially introduced transplants of *Hopea*, survivals of previous year are coming up well and the best plant is 3' 6" high. Six Burma bamboo cuttings are doing well.

*Artificial regeneration of Hopea parviflora under shade in forest openings.*—Out of 530 seedlings planted in previous years 365 were surviving, i.e., 73 per cent. A further opening was given during February 1938 and casualties were also replaced. The plants are coming up well and the best plant is about 18" in height.

*Frill girdling and poisoning with sodium arsenite.*—The experimental area (Urti coupe) was under observation during the year. Concentrations of poison used were  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$  and  $\frac{1}{16}$  of solution as originally supplied; and the girth classes were 2' 6"—4', 4'—5' 6", 5' 6"—7' and 7' and above. The poison was applied during October and November

1936 and in all 455 trees are under observation. So far girdling and application of  $\frac{1}{10}$  concentration of solution seems to have had not much effect. In the other three, more than 50 per cent. of the trees are dead. Girths seem to be of no consideration as regards the effect.

The natural regeneration in this area is splendid and the plants are growing vigorously. The gradual opening created, as a result of the slow process of dying of the overwood trees, appears to be the most suitable method for the development and increase of natural regeneration of valuable species in these evergreen forests.

## MADRAS.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) General.

*Results and indications.*—Space does not permit here mentioning all items of work undertaken. For fuller information the “Annual Report on Silvicultural Research in the Madras Presidency for the year 1937-38” published separately should be consulted.

A large proportion of the work done has been small scale stage I(a) experiments and routine seed germination and weighment tests. The most important results obtained during the year are probably :—

- (a) The extension and great improvement in the regeneration of dry fuel forests by the “rab” method and its combination with the raising of field crops (*rab-cum-kumri*). In many districts with the most unpromising soil and climatic conditions success with this kind of work is now routine and height growth of 2 to 5 feet in the first year is common.
- (b) Further demonstration of the great benefits obtained by soil working by forking in the early stages of the “rab” regeneration of dry fuel forests.
- (c) In very poor areas in such forests, the successful raising of plantations for manure leaves of *Cassia siamea* and *Poinciana elata* and plantations for tan bark of *Cassia auriculata* (Avaram).
- (d) Continued success in the control of new outbreaks of the spike disease of sandal.
- (e) Progress towards the identification of the insect or insects responsible for the spread of the spike disease of sandal. It has also been proved that it is an insect that operates at night and between August and November as its main infective season.

- (f) The conclusion of the investigations into the best date of stump planting and best size of stumps to use for most of the important local species.
- (g) The further collection of statistics of teak stump production in nurseries and the methods by which economies can be made. In conjunction with this is the demonstration of the fact that in years of shortage (due to bad seed years), undersized stock in the nursery can be developed into good stock for the following year.
- (h) The controlling of the mahogany pests by silvicultural methods of using shade crops and segregation is showing marked success.
- (i) Analysis of data for the compilation of new yield tables for Nilambur teak has shewn that the number of stems, basal area, and volume, per acre, when expressed in terms of "top" height are independent of age and quality; accordingly, a table of thinnings has been prepared which will be of the greatest use to district officers.

#### *Financial aspect of silvicultural research.*

(a) *Teak Plantations*.—The revolutionary change in the technique to raising plantations by pre-monsoon stump-planting in crowbar holes and the improved weeding and tending methods have reduced the cost of formation by Rs. 10 to Rs. 15 per acre, amounting to an annual saving of over Rs. 17,000 in the Province.

These improved methods of formation, tending and thinning will (according to all present indications) lead to a reduction of the plantation rotation of about 10 years, which means a great increase in the potential value of the present plantations.

*Spike disease of sandal*.—By the control operations done by the research staff in North Salem division during the past 5 years, an average annual loss of Rs. 21,000 is claimed to have been averted in one district alone.

#### *(ii) Natural Regeneration.*

##### *By Seed.*

Experiments with *Hopea parviflora*, *Calophyllum elatum*, *Dysoxylum malabaricum* and *Mesua ferrea*, so far show that clearing undergrowth and raking the soil under ~~the~~ <sup>other</sup> trees are not beneficial in inducing natural regeneration. The indication is not conclusive yet.

Canopy opening over young regeneration of *Hopea parviflora* was found to be very beneficial but produced no notable effect on *Mesua ferrea*. Further experiments with *Palaquium ellipticum* have been started.

Experiments have been started to determine why at Nilambur some mature trees of *Swietenia macrophylla* have a dense mass of natural regeneration under them while other trees produce none. Results so far show that seed production, seed fall, and germination are normal and that the seedlings survive the first hot weather. It remains to be seen when and why this regeneration disappears.

Partial canopy removal over dense regeneration of *Pterocarpus santalinus* produced a very beneficial effect in spite of 2 years' unfavourable climatic conditions.

### By Coppice.

Experiments in the dry fuel forests of Chittoor district showed that the ordinary operation of coppicing causes a mortality of approximately 9 per cent. of the stools and that trimming of the stools is definitely harmful in such areas.

A large scale (30 acres) experiment was done towards the effect of height and method of coppicing teak on the mortality of stools. It is of interest to note that so far mortality with this species has been negligible (about 1 per cent.); and that the main coppice shoots come from very near the ground level irrespective of the height of coppicing.

### (iii) Seed.

*Seed pre-treatment.*—Routine pre-treatment tests were done with 27 species. Treatment with boiling water improved the germinative capacity of *Acacia auriculiformis*, *Acacia cyanophylla*, *Acacia baileyana*, *Acacia decurrens*, *Bauhinia purpurea*, *Pinus longifolia* and *Acacia dealbata* but was harmful for nearly all other species tried. Soaking in cold water was beneficial to *Gluta travancorica*, *Pterocarpus santalinus* and *Xylia xylocarpa*, being very marked in the case of the *Pterocarpus*. Concentrated sulphuric acid hastened and greatly improved the germination of *Cassia fistula*, *Cassia auriculata* and *Cassia marginata* while fermenting greatly improved that of *Terminalia chebula*.

*Seasonal collection.*—Tests made with 10 species again showed no definite variations in germinative capacity throughout the fruiting season.

*Seed storage.*—Routine tests were made with 33 species to determine the longevity of the seeds stored in different ways. (Vide results in the full Annual Report.)

*Seed weighments.*—Routine tests were carried out as usual. (*Vide* results in the Annual Report.)

*Sorting seed by size.*—Previous years' results that the sorting of teak seed by size is not justified economically were again confirmed. Tests with seeds from small immature, normal mature, and large over-mature seed-bearers with 4 species showed no appreciable differences in germinative capacity, or height growth of the resulting seedlings. Large scale experimental plots have been established to test the effects in later growth.

*Seed origin.*—There are two large scale long term experimental plots, each 4 years old. In the Nilambur plot, 20 of the 24 sub-plots were given a 50 per cent. mechanical thinning and were formed into 20 sample plots. This thinning at the age of 4 years is in accordance with the proposed prescriptions of the working plan, under revision.

#### (iv) Nursery Work.

In evergreen nurseries protection by sheltering from the very heavy rain of the south-west monsoon resulted in a much higher percentage of survivals with *Artocarpus hirsuta*. In the hot weather, seedlings of *Hopea parviflora*, *Dysoxylum malabaricum*, and *Cedrela toona* benefited greatly by shade in the nursery.

An experiment on nursery watering in a dry fuel area showed again that watering should first be very light until germination is over and increased thereafter.

Work on different nursery methods for raising teak stumps confirmed previous years' results that for 1 acre of plantation at a 6'×6' spacing, the best outturn of good stumps is obtained by sowing seed at the rate of 20 to 30 lbs. per standard 40'×4' bed and doing no pricking out of seedlings at all.

Further experiments also showed that if owing to a poor seed year and consequent shortage of stumps, the undersized stumps have to be used, they are best put back into the nursery beds as stumps for a second year. At the end of the second year some 60 per cent. (as against 70 per cent. of the previous year) of them will have grown to the right size and they can then be stumped again and planted out.

Experiments to determine whether teak nursery beds deteriorate if they are used repeatedly and if their fertility can be maintained by artificial or green manures were continued. Results so far show slight deterioration by the 3rd year but an increase of 18 per cent. (as against 5 per cent. in the previous year) in the utilizable stumps produced in the beds manured with wood ash and leaf mould.

(v) *Artificial Regeneration.*

## (a) Mixed deciduous timber forests.

As regeneration of this type of forest by small gaps has definitely failed, experiments have been started in the regeneration of such areas by raising a valuable crop under the comparatively worthless shelter-wood. These experiments appear promising at present with a definite indication that under these conditions direct sowing is unlikely to succeed owing to drip. Several valuable species have however been raised by transplanting or stump planting. It is however too early to give definite results.

*Comparison of sowing, transplanting and stumping.*—Previous years' results were confirmed and showed that for teak, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata*, *Terminalia paniculata*, *Schleichera trijuga* and *Artocarpus hirsuta* stump planting is the best of the 3 methods while for *Xylia xylocarpa* direct sowing is to be preferred. *Pterocarpus dalbergioides* and *Swietenia macrophylla* do best by transplanting.

*Optimum season for stump planting.*—The majority of the investigations into the best date of stump planting principal species (most of which stump well) which have been going on during the past 6 years at 5 centres have now been concluded.

Detailed results will be found in the full report but the general conclusions are :—

- (a) In districts having a west coast type of climate, the principal species such as *Tectona grandis*, *Dalbergia latifolia* and *sissoides*, *Pterocarpus marsupium* and *Terminalia crenulata* can be stump planted before the monsoon breaks.
- (b) Except in unusually hot and dry seasons, this early stump planting gives a sufficiently good stocking (often much better than early June planting) and a great gain in height growth as compared with normal early June monsoon planting.
- (c) Success is not dependent on what is generally considered "good planting weather".
- (d) The great advantage given by the start the teak or other species get over weeds or field crops more than outweighs any risk of poor stocking, and this risk can be insured against by providing a reserve of plants for stumping in early June if the necessity should arise.
- (e) The best dates of planting each species at each centre have been provisionally indicated to be confirmed by further experiments.

District experimental work in Kurnool West division over the past 3 years shows that teak is best stump planted about 3 weeks to a month before the rains set in. It is emphasized that the best date of stump planting is essentially a local problem and each district must do its own experiments and obtain its own local data.

*Stump planting—effect of age and diameter of stumps.*—As previously reported teak stumps of 0.4" to 0.8" diameter at the thickest part gave the best results though stumps of 0.3" to 0.4" diameter are definitely "usable" in the event of shortage of the larger stumps though they do not give as good results.

Work with *Dalbergia latifolia* again showed that 2-year old stumps are better than 1-year old ones and 0.2" to 0.6" diameter is the best range of size. For *Pterocarpus marsupium* results indicate that the larger stumps of 0.4" to 1.0" diameter give the best results. Results for *Terminalia crenulata* show 0.4" to 0.8" diameter to be the best size, and for *Artocarpus hirsuta* within the range experimented with, the bigger and older the stumps the better the results.

*Stump planting—pits and crowbar holes.*—Experiments in stump planting teak in pits and crowbar holes in Kurnool West division during the past 3 years have shown that pit planting gives a 30 per cent. increase in height growth over crowbar hole planting but no advantage in survival percentage. But, in districts having a West Coast type of climate, no advantage at all is gained by pit planting.

Experiments in burying teak stumps when planting them compared with normal planting showed no differences for normal 1st June planting but buried stumps were definitely better in the case of pre-monsoon (April 1st) planting.

*Storage of stumps—teak.*—Experiments again showed that stumps can be successfully stored for 2 weeks before planting even in an abnormally bad year (climatically).

*Irrigated plantations—teak.*—Preliminary experiments in this subject show that irrigation by flooding (as in paddy cultivation) is more difficult and more expensive to do than irrigation by percolation from channels and gives no better results. Flooding also uses much more water.

Experiments were continued with *Suietenia macrophylla* to determine the best espacement and the best shade conditions in which to grow the species. The season and incidence of its 2 great pests, the shoot borer and the collar borer, are also being determined under these various conditions. Shade very definitely reduces the incidence of the shoot borer.

A number of experiments were done to determine the best method by which to regenerate *Bambusa arundinacea* and *Dendrocalamus strictus*,

So far it appears that rhizome planting is more successful than transplanting or sowing.

A long term plot has been opened to determine whether the "figure" of *Terminalia crenulata* (*tomentosa*) is hereditary.

*Casualty replacements in 2nd year teak-plantations.*—Results so far indicate that few of these replacements survive and it is doubtful if they ever take their place in the main crop.

*Effect of taungya (ponam) crops on teak plantations.*—Previous work was repeated and shows that "ragi" (*Eleusine coracana*) retards the height growth of the teak by 40 per cent. in the first year while "dhall" (*Cajanus indicus*) has very little effect. This retarding effect of the *taungya* crop can be greatly minimized by early planting the teak.

Experiments were continued in the raising of semi-evergreens such as *Artocarpus hirsuta*, *Cedrela toona* and *Hopea parviflora* on areas which were probably originally evergreen and which through repeated shifting cultivation had gone deciduous. These experiments look very promising.

Entomological work in the control of teak defoliators and on the pests of mahogany was done by the Forest Entomologist, Dehra Dun.

#### (b) Evergreen rain forests.

All artificial regeneration work in evergreen forests (with the exception of experiments on raising evergreens after clear felling and burning) being mostly 'underplanting' has been dealt with under that head.

#### (c) Dry fuel forests.

Artificial regeneration of dry fuel forests by the "rah" method is being done on a larger scale each year with better results as the technique improves.

The greatest advance of the last few years is in the raising of these dry fuel species in conjunction with field crops such as *ragi* (*Eleusine coracana*), castor (*Ricinus communis*) and cotton (*Gossypium barbadense*).

Results of experimental and district "rah" work show that regeneration is best raised by direct sowing with most species. The best date of sowing varies greatly each year and the most practical method found is to sow early and to go on resowing at reasonable intervals until full stocking is obtained. (Seed is generally plentiful and cheap.) Transplanting and stump planting are in general not suitable to these species in this type of area.

The following species have given excellent results:—*Cassia siamea*, *Albizia lebbek*, *Azadirachta indica*, *Dolichandrone crapa*, *Acacia sundra*,

*Albizzia odoratissima*, *Pterocarpus santalinus*, *Albizzia amara*, *Wrightia tinctoria*, *Zizyphus jujuba*, *Pithecolobium dulce*, *Acacia ferruginea*, *Prosopis juliflora*, *Tamarindus indica*, *Acacia planifrons*, *Acacia arabica*, *Pongamia glabra* and *Cleistanthus collinus*.

A good hurn coupled with soil preparation before sowing is essential for this work.

Soil working during the 1st year is very beneficial. It not only produces a much increased height growth but also enables backward plants to survive the hot weather.

Successful work has also been done in the raising of plantation to be worked for manure leaves by the planting of large shoot cuttings of *Poinciana elata*. The same purpose has also been served by direct sowing of *Cassia siamea* and *Poinciana elata* but of course such sowings take much longer to mature.

Stump planting of *Santalum album* has given a large measure of success and it has also been demonstrated that sandal stumps can be kept in air tight tins without deterioration for 3 weeks before planting.

*Cassia auriculata* (the 'Avaram' bark of commerce) has been successfully introduced by sowing in order to raise concentrated plantations of this species. Very little difficulty has been experienced even under the poorest conditions of soil and climate in our hottest districts.

#### (vi) Afforestation.

Experiments to examine the probability of reafforesting some of the more important catchment areas of the Nilgiris were continued and so far have given the following general indications as mentioned in last year's report :—

- (a) The moister localities can be easily stocked with willows by cuttings. They are frost hardy but need protection from browsing.
- (b) Small, close planted, concentrated plots do better than large areas of open planting owing to more efficient frost protection being possible.
- (c) Frost protection is best done by means of a complete pandal about 1' 6" from the ground and screened on the up hill side.
- (d) Nurse species can be raised as follows :—
  - (i) Broom by sowings.
  - (ii) *Buddleia* spp. by cuttings.

- (iii) *Ligustrum neilgherrense*, *Rubus moluccanus*, *Rubus lasiocarpus*, *Myrsine wightii* and *Hypericum mysorense* by planting stumps got from the forest.

(e) Tree species can be raised as follows :—

- (i) *Acacia dealbata* by 2 year old large transplants.
- (ii) *Cupressus macrocarpa* and *Callitris rhomboidea* by small transplants and these can come from the forest if necessary.
- (iii) *Acacia melanoxylon* and *Eugenia arnottiana* by mossed transplants.
- (iv) *Mahonia leschenaultii* by stumps and these can come from the forest.

The indications of present knowledge are that a possible solution to the problem of afforesting the grass areas is—(a) fencing the selected area, and fire protecting it by a scraped and burnt fireline, (b) selecting 10' square patches inside the fenced area, (c) working the soil 1' to 1½' deep in such patches, and removing all grass and roots, (d) sowing broom seed broadcast in these patches, (e) covering the broom plants in the patches by a pandal in the first year as this has the effect of forcing the height growth of the broom, (f) then leaving the patch for the second year to establish itself, and (g) planting under this broom other frost tender tree species that are intended to be raised.

(vii) *Tending, Thinning, Cleaning, etc.*

**Weeding practice.**—Large scale experiments were done in continuation of the work of the past few years and results again conclusively confirm previous years' results that the slightly beneficial effect (if any) of forking as opposed to mamooty scraping as a weeding method in the first 2 years of a teak plantation in our better teak areas is in no way commensurate with the extra cost of forking.

**Effect of a cover crop of *Leucaena glauca* on a teak plantation.**—In an experiment in this subject the teak with the cover crop showed an increased height growth over that of the control teak at the end of the first year but this increase had greatly diminished to only 8 per cent. by the end of the 3rd year. The *Leucaena* was continuously browsed by deer and hison and was no use at all as a weed suppressor.

**Thinning research—teak.**—All plots in this subject were maintained.

**Bamboos.**—Experiments on the intensive tending and working of bamboos were continued and showed that such intensive work is economically justified by the improvement in the condition and yield of the clumps and the increased revenue obtained.

(viii) *Mixtures*—Nil.(ix) *Underplanting*.

(a) *Teak plantations*.—All plots were maintained and new plots of *Bambusa polymorpha* were established. Experience so far indicates that teak plantations can be successfully underplanted with *Bambusa arundinacea*, *Cephalostachyum pergracile* and *Hopea parviflora*. *Swietenia macrophylla* and *Cedrela toona* although established suffer a great deal from browsing and bark stripping by deer.

(b) *Evergreen rain forests*.—Experiments in the regeneration of evergreens with and without a cover crop after clear felling and burning evergreen forest have been started and show some promise. Most of the work of the past few years have been in underplanting under various degrees of canopy.

As mentioned previously, general results are :—

- (i) Top canopy cover gives the best results.
- (ii) Burning before regeneration produces no beneficial results.
- (iii) For most species transplanting is the best method and some of the tenderer species do well if mossed or hasketed.
- (iv) Stump planting is not a suitable method for most evergreens. The exceptions to this are *Artocarpus hirsuta*, *Cedrela toona* and *Chickrassia tabularis*.
- (v) Weeding is worth while as it gives a slight gain in height growth and survival percentage.
- (vi) Pitting for planting is also similarly worth while although the effects of pitting do not show until the second year when the roots and their needs have both got bigger.
- (vii) The best date of transplanting for most species is mid June or early August i.e., either just before or just after the heaviest rain of the South-West monsoon.
- (viii) For most species the best size of transplant to use is from 8" to 1' high. Larger transplants occasionally do well but suffer heavy casualties and are not definitely established for several years. In the case of large transplants of *Cedrela toona* and *Swietenia macrophylla* insect attack is more serious than with small plants.

(xi) *Miscellaneous*.

*Sandal Spike Disease Research*.—A brief summary of results so far is :—

- (a) Spike is an insect-borne disease.

(b) The insect or insects responsible cannot pass through a mesh of  $1/20''$  but can pass through one of  $1/4$ th inch.

(c) The insect responsible operates at night and in one main season of August to November with a secondary season in April-May.

Anti-spike operations carried out continued to be successful and indicate that such control measures are fully effective in the case of areas where only a few trees are found infected and that in the case of large blocks of forest where the disease has been allowed to spread for some years uncontrolled the effect of the control operations is to confine the disease to the original limits of the outbreak.

The loss of revenue averted by the success of these control measures is already considerable.

*Periodicity of height growth.*—Indications are the same as recorded in last year's report. Weekly measurements showed that in deciduous forest the general rest period was from the middle of November to the middle of April. In evergreen forest and in dry fuel forest most species grow slowly but steadily all through the year.

*Weeds—Lantana eradication.*—Experiments in the suppression of *Lantana* by underplanting it with *Bambusa arundinacea* were extended and continue to look promising.

Large scale experiments in destroying this pest by spraying with a Sodium chlorate spray show that the method is the most successful and least expensive of any method so far tried.

Experiments on the suppression of *Eupatorium* by means of *kikiyu* grass (*Pennisetum clandestinum*) were extended and continue to look promising. This work is most important in the reclamation of grazing areas which have been invaded by the pest.

## II.—WORKING PLANS AND STATISTICS.

### (i) Working Plans.

Five working plans were under preparation at the beginning of the year and 5 were completed during the year. 2 new plans were started during the year.

The cost of preparation inclusive of establishment was :—

	Per acre.
(a) Vellore East Working Plan	3.9 annas.
(b) Cuddapah South Working Plan	1.5 annas.
(c) The Nilgiris Working Plan	4.2 annas.

(ii) *Yield, Volume and form factor tables.*

During the year the Central Silviculturist, Dehra Dun compiled new (provisional) yield tables for Nilambur plantations. The great practical point that has arisen during the preparation of these tables is that if the number of stems per acre is plotted against "top height" (instead of against age as is usually done), the resulting curve is practically independent of quality of locality or age.

Hence it has been possible to prepare a table of top heights and the corresponding number of stems per acre that should be present.

145 sample plots representing 16 species were maintained; 20 new sample plots at Nilambur to compare teak growth from different origins and 5 new teak sample plots in the Wynad division were opened.

36 Tree Increment Plots and 18 preservation plots were maintained.

## III.—MISCELLANEOUS.

*Tours.*

The Provincial Silviculturist toured for 190 days during the year. The sandal spike disease research works in North Salem division were inspected by him and also by the Forest Botanist, Dehra Dun.

The Provincial Silviculturist was deputed to the "Research demonstration Course" held at the Forest Research Institute, Dehra Dun, in October 1937.

The Forest Botanist, Dehra Dun, visited all the four linear tree increment plots which were opened during the year, and he started the work of tree identification in all these places.

The Central Silviculturist, Dehra Dun, also visited and inspected the Research Experimental works at Chandanathode Kannothe, Nilambur, Nilgiris, Emmanur, Walayar, Dhoni, the irrigated teak plantations at Hulical drug and the district "rah" and "kumri" works in the Ayyalur range of Madura district.

*Books and Publications.*

"The note on a tour in South Bengal" is about to be published soon.

The following pamphlets were written during the year by the Assistant Silviculturist and submitted to the Chief Conservator of Forests, Madras.

1. A note on the cultivation of the Green wattle (*Acacia decurrens*) in South Africa and South India.
2. A short note on *Cassia auriculata*.
3. A note on the financial aspect of planting wattle (*Acacia decurrens*) in the Nilgiris.

The results of some of the closed investigations were summarised and written up as pamphlets by the Provincial Silviculturist during the year.

They are :—

1. An investigation into the best date of stump planting teak (*Tectona grandis*) at Begur, Dhoni, and Topslip.
2. An investigation into the relative merits of planting teak (*Tectona grandis*) stumps in pits and crowbar holes in areas having a west coast type of climate.
3. An investigation into the best root lengths of stumps to use when stump planting teak (*Tectona grandis*).

All the above three investigations are being published as "Indian Forest Records" by the Forest Research Institute, Dehra Dun.

Besides the above, two sets of Research experiments on soil working in dry fuel forests (Emmanur) in Coimbatore North Division were also summarised and submitted to the Chief Conservator of Forests.

#### *Records.*

The Specific and general Ledger files now number 436 and 156 respectively.

41 new Experimental Plots and 192 new Experimental Garden experiments were opened during the year while 11 experimental plots and 151 Experimental Garden Experiments were summarised and closed. At the end of the year 106 Experimental Plots and 328 Experimental Garden experiments were open.

176 Photographs were added to the collection during the year and the total number of photographs now ledgered is 636 under specific and 320 under general ledger files.

#### *Staff.*

The Extra Assistant Conservator of Forests remained in the division throughout the year as assistant. The subordinate staff now consists of 3 Research Rangers, 9 Foresters, and 1 Forest Guard.

### NORTH-WEST FRONTIER PROVINCE.

#### I.—*Experimental Silviculture.*

##### (i) *General.*

The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*), and silver fir (*Abies pindrow*) particularly in forests worked under the uniform system.

(ii). *Natural Regeneration.*

The experimental plots previously laid out to ascertain the most suitable intensity for a seeding felling in blue pine forest have given no definite results and have now been given up. In their place experimental plots have been established by the Punjab Research division to study the effect of the following factors on blue pine seedlings :—

- (a) Grazing,—normal, controlled and completely closed.
- (b) Removal of *Viburnum* weed, and method of removal by cutting it at ground level, 2' to 4' above ground, treating it with Sodium arsenite and spraying it with Sodium chlorate.
- (c) Rodent damage.
- (d) Density of overwood.
- (e) Soil working.
- (f) Different aspect and soils (shale not yet included).

Plots 1 to 4 (with 18 sub-plots) were laid out to study the factors affecting the progress of seedlings in the recruitment (unestablished and established stages) while plot 5 (with 8 sub-plots) was designed to study the effect of (i) grazing, (ii) removal of *Viburnum* by cutting or poisoning, and (iii) exclusion of rodents on the influx of natural seedlings of blue pine.

(iii) *Seed.*

The year 1937 was a poor seed year for deodar, silver fir and chir, but was moderately good for blue pine.

(iv) *Nursery Work.*

In addition to the ordinary nurseries, maintained in the hill divisions, for re-stocking the areas felled over, a large nursery is maintained at Nowshera, and others at Cherat, Parachinar, and Malakand in the Peshawar Division, for the supply of plants required for station planting and the re-planting of canal banks. A large nursery is also maintained at Razmak for the supply of fruit and garden plants, and despite the unsettled conditions of Waziristan, no less than 15,000 plants were distributed during the year.

(v) *Artificial Regeneration.*

*Cedrus deodara*.—Sowings of deodar on burnt patches continue to give marvellous results in the blue pine regeneration areas in Upper Siran range. The resulting crop after the first seeding felling has every prospect of being at least 50 per cent. deodar. Surplus plants transplanted from these patches have also done well, success being 70-75 per cent.

*Pinus excelsa*.—In Upper Siran, blue pine seed sown broadcast during the monsoon, after soaking in water for 48 hours, has germinated well, but it remains to be seen how much will survive.

*Pinus longifolia*.—During the last five years *chil* plants raised in tin tubes have been successfully planted in Cherat Cantonment and Malakand Agency forests. But the subsequent development of the plants is unsatisfactory chiefly because of the unfavourable condition of the soil.

*Nannorrhops ritchiana*.—Experiments on the propagation of this species, both by sowing in interrupted channels and planting of off-sets without artificial irrigation, were carried out in Jarma sample plot for three years, but without success. This year seed was sown in 100 horizontal interrupted channels in Khawara with encouraging results, as not only was germination good, but a fairly large number of seedlings are still surviving. The soil in Khawara is rocky whereas in Jarma it was clayey from which it appears that the former is preferred by this species.

#### (vi) Reclamation, etc.

A considerable area of Upper Siran forests was burnt by a fire in the winter of 1932 and almost laid bare of existing vegetation and seed bearers. An acre of this area, open to grazing, was raked up and sown broadcast with *Indigofera* seed in April last year. The seed germinated profusely during the monsoon but the young plants were considerably damaged by grazing. The idea was to raise nurseries to afford shelter to blue pine and deodar regeneration.

#### (vii) Tending.

The effect of early cleaning on deodar sown on burnt patches is shown by the following averages of measurements made in one patch. Sowings were made in December 1935 and germination took place in April 1936, so at the time of cleaning in July 1937 the plants were 15 months old :—

No. of plant	Average height on 7-9-37.	Average height on 16-9-37.	Average height on 1-5-38.
8	1' 4"	2' 0"	2' 2"

#### (viii) Miscellaneous.

*Grazing*.—In the case of our regeneration areas, where the young crop is established, the effect of increasing the grazing incidence from 8 acres to 6 acres per head of cattle continues to be beneficial. During

growth of *sheroo* (*Imperata* spp.) grass is kept down and chir seedlings are beginning to appear in places where they had hitherto failed.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working plans.*

The revision of the Galis working plan was completed. This prescribes the selection system for all forests capable of being worked for revenue, in place of the uniform system under which they were previously managed. The Inspector General of Forests visited these forests in May 1937 and on his recommendation the yield was fixed at 1.5 per cent. of the enumerated growing stock for blue pine and 1.3 per cent. for silver fir. With blue pine this is rather less than Von Mantel with a 120-year rotation, which would work out at 1.66 per cent., while with fir it is almost the same as Von Mantel with a 150-year rotation, viz., 1.33 per cent. Regarding the latter percentage the Inspector General remarked that in view of the age class distribution it was probably more than should be felled; and that on the other hand much of the older stuff was deteriorating and had better be removed.

### (ii) *Yield, volume and form factor tables.*

The measurement of old sample plots was carried out by the Punjab Research division,—nine sample plots in the Galis division (blue pine) and one (chir) in the Kagan division, which were due for re-measurement.

## ORISSA.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

As in 1936-37, Mr. J. W. Nicholson, I.F.S., had to carry out the duties of Research Officer in addition to his duties as Conservator of Forests. It was possible to make some progress in laying out new experimental plots but, owing to pressure of administrative duties, the execution of the work had to be left mainly to the Research Forest Ranger. Mr. D. H. Khan, who was newly posted to the Province as Research and Working Plans Officer, is expected to take over the duties of Research Officer about October 1938 after he has had some preliminary training at the Forest Research Institute; and it is intended to draw up, in consultation with the Central Silviculturist, a triennial programme of silvicultural research work to commence from 1939-40.

Following upon the decision made in 1936-37 to confine research work to really important problems the previously existing experimental plots in the Ganjam division were closed down.

Out of a total of 66 experimental plots distributed over 6 divisions 30 were abandoned and 14 new plots laid out during the year, and the total number of plots at the close of the year has been 50 only.

### (ii) *Natural Regeneration.*

*Sal.*—The most important problem is the re-obtaining of sal regeneration in the *mals* forests of Puri Division. During the year the series of experimental plots was not examined for progress. A dry cold weather enabled burning to be carried out far more efficiently than in previous years and an excellent seed year followed. Unfortunately, owing to a mistake, some plots were not burnt according to programme.

Plots previously established in Chatrapur division to investigate methods of producing sal regeneration by manipulation of the canopy were abandoned, as it was found that existing regeneration was more or less normal for the type.

In Ganjam division the six experimental plots in Rambha Reserve were abandoned. The treatment produced a profuse invasion of bamboos instead of resulting in any increase of established sal regeneration. In their place a new plot, has been laid out to test the possibility of establishing regeneration of sal and other valuable species by removing inferior species in the canopy and thereby admitting more light.

The series of 24 experimental plots in Galleri reserve laid out to trace the history of young sal regeneration were also abandoned during the year, as no reliable results could be expected. In their place 3 new plots were laid out in the Plains Sal Timber Working Circle. In one plot the crop has been left unfelled; in the second, the crop was felled and will be cleared according to the present working plan prescriptions; and, in the third, the crop was felled but it will be left uncleared. Two new experimental plots were laid out in a 9-year old sal forest (Plains Sal Timber Working Circle) with the object of testing the effect on sal natural regeneration of annual early burning as compared with complete protection for 4 years followed by a late fire every fifth year.

An experimental plot was laid out in Kusumjhor Coppice Felling Series, Sambalpur Division, to ascertain the effect on coppice growth of retaining standards.

In Angul division the main problem, in the old P.B.I., is to find out how best to assist sal regeneration against *Bambusa arundinacea*. Burning the clumps results in very untidy growth as well as affording good support for climbers. Clear felling the clumps gives the best

results, and efforts are now being made to get bamboo contractors to carry out clear felling where such is wanted.

*Teak*.—2 experimental plots were laid out in Puri division, to test the effect of early burning in teak plantations established in the dry Puri coastal type of forest. Teak regeneration in damper types is usually found only under mother trees growing in the open. Experiments to increase natural regeneration in Ankula teak plantation are said to be yielding good results.

*Casuarina*.—Layering experiments have not proved successful as so far only 10 per cent. of the layered branches have taken root.

*Miscellaneous*.—2 experimental plots were laid out in a Coppice Felling Series of Puri division, to test the effect of early burning on the regeneration of important tree species in dry evergreen thorn forest.

### (iii) *Seeds*.

Nothing of importance to record.

### (iv) *Nursery Work*.

The *dona* system of raising nursery seedlings was tried in several divisions. The system appears to be one worth following where stump planting is not possible (as in teak *toilas*\*), or where there is a shortage of stumps, and, in the case of species which do not stump well. The system can only be followed, however, where the nursery and water are near the plantation site.

In Angul division an experiment was tried to raise teak stumps in dry *rab* nurseries. The results have been most encouraging as 50 per cent. of the plants have proved fit for stumping at one year's age. With improved technique a higher percentage should be obtainable. The advantages of this system are the very low nursery costs and reduced expense in carriage of plants to the planting site.

### (v) *Artificial Regeneration*.

*Rab* sowings were tried in several divisions. In Barapahar, on poor dry soil, successful results were obtained with *Adina cordifolia*, *Gmelina arborea*, *Terminalia tomentosa*, *Dalbergia latifolia*, *Lagerstroemia parviflora*, *Pterocarpus marsupium*, and *Albizia procera*, but considerable damage occurred from browsing in unfenced plots. In the 1936 *rab* sowings *Pterocarpus marsupium* and *Dalbergia latifolia* have reached a height of 5 feet. In Sambalpur, results were less successful due, it is thought, to late sowings. In Chatrapur, teak, *Casia siamea*, *Acacia arabica* were tried, but owing to shortage of rain the results were not so

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\* Dry cultivation or *taungya*.

good as in 1936-37. In Puri, *rab* sowings of teak were a failure due to the use of immature seed. In Angul, *rab* sowings of teak, *Gmelina arborea* and *Ougeinia dalbergioides* gave good results on suitable soil. Experiments are being undertaken on a still larger scale in 1938-39.

Sandal sowings were done in Chatrapur and Parlakimedi divisions. It has been found necessary to revise the methods laid down in the working scheme which insisted on clean weeding and sowing of host plants. The older method under which sandal seeds were sown under bushes with existing forest trees as hosts has given far better results. Further, instead of sowing (or planting) sandal inside forest areas it has been decided to carry out sowings by forest subordinates free of cost along roads and boundary lines wherever lateral shade and suitable hosts are available.

In Puri division, *dona* planting of teak in teak plantation areas gave very good results. Experiments in line planting of teak were carried out. The original evergreen forest was felled and the teak planted in lines 24 feet apart. Where *toila* cultivation is not possible such line planting, judging from the results of old line plantations, should prove most successful.

(vi) *Reclamation and Afforestation including irrigated plantations.*

The experiments in the afforestation of dry type soils in Motijhoran reserve, Sambalpur division, were continued. Of cuttings tried *Boswellia serrata* and *Erythrina suberosa* gave the best results. 12 different species were planted out by *dona* methods. The most successful as regards survival have been *Kigelia pinnata*, *Prosopis glandulosa*, *Pterocarpus marsupium*, *Anogeissus pendula*, *Holarrhena antidysenterica*, *Thespesia lampas*. *Prosopis juliflora* has been partially successful. The season was an unfavourable one, and the results achieved are as good as could have been expected. Until the plants have pulled through two hot weathers results cannot be definitely assessed. To hold up run off in this area, gullies were hunded and planted with *sabai* (*Pollinidium angustifolium*) grass.

In Barapahar division afforestation experiments were similarly carried out on dry infertile soil. Contour ridging at 4 feet vertical intervals, planting of cuttings, *dona* planting and line sowings of sal were tried. *Dona* plants of *Anogeissus pendula* and *Prosopis juliflora* did well to begin with but later suffered many casualties. *Dona* plants of *Pterocarpus marsupium* alone give any promise of success.

Experiments were continued in planting out *Dalbergia sisoo* and *Albizia procera* in abandoned paddy fields in Sangramal reserve of Sambalpur division. *Dona* planting and one year old stumps were tried. Very poor results were obtained, attributed to a poor rainy season and subsequent drought.

65 rhizomes of *Bambusa vulgaris* were planted in the Puri *Casuarina* plantation, out of which number 54 were surviving in good condition.

Anti-erosion experiments in Chandragiri reserve, Russelkonda division, were continued. In Orissa, as well as in most other provinces in India, the problem of erosion has not received the attention it deserves. Erosion is mainly due to misuse of land by cultivators and graziers but it is also caused by faultily constructed and drained roads as in the Agency tracts, for instance. The problem is of such magnitude that it can only be tackled by an All-India Soil Conservation Service established on the lines of that in the United States of America.

#### (vii) *Tending.*

Useful information was obtained from the experiments on the Plains Sal Timber Working Circle in Russelkonda division in regard to cleanings in one-year old sal crops. The experiment indicates that cultural operations should be left until the end of the hot weather when it is not difficult to uproot perennial climbers as soon as the first heavy rain loosens the soil. A further experiment in reducing tending costs was tried by abandoning in one half of the previous year's coupe the costly prescription for cutting back, heaping and hurning. After the rains it was found that the condition of the crop in the untreated area was as good as in the treated area, and it was, of course, more advanced.

A thinning experimental plot was laid out in a 10-year old coppice coupe of Puri division, to ascertain the effect of reduction of coppice shoots of *Xylia xylocarpa* at ages of 10 and 15 years. A similar plot was laid out in a 10-year old coppice coupe in Sambalpur division, sal being the species under treatment. In Barapahar division a similar but more complicated experiment was carried out in a 10-year old coppice coupe, *Cleistanthus collinus* being the species tested.

The revised thinning rules introduced in Samhalpur and Barapahar divisions have given very good results. Rules on similar lines were drawn up for the Coppice Working Circle of Puri division, where wholesale thinning of all species has given poor results.

Climber poisoning experiments were initiated in Raigoda, Angul division ; the results are as yet inconclusive.

#### (viii) *Mixtures.*

*Nil.*

#### (ix) *Underplanting.*

Underplanting of *Dendrocalamus strictus* forest with teak stumps was tried in Barapahar division in a coupe due to be coppiced

two years later. Initial results are very promising. Teak was introduced in lines 24 feet apart in certain blocks in Angul division. The plants are surviving but, due to heavy overhead shade, are not putting on satisfactory growth. Experiments under lighter shade will now be undertaken.

(x) *Silvicultural systems.*

The Palamau system of not compelling clear felling in coppice coupes was tried in Sambalpur and Russelkonda divisions. In both the market demand for small wood was sufficiently good to induce contractors to clear fell. Only in hilly inaccessible areas in Sambalpur advantage is being taken of the new system. In one coppice coupe in Russelkonda, all sal poles under 6 inches in diameter were reserved. The method is reported to have been successful.

(xi) *Miscellaneous, including fire and grazing.*

Early burning has been carried out in most Divisions. Experience so far gained is that only in very dry forests, such as those of Barapahar division, which can be burnt really early in the season, can early burning be relied upon to give good results, but in mixed bamboo forest, such as occurs in Angul division, fairly satisfactory results are obtainable. In sal forests, in Chatrapur, Russelkonda and Sambalpur divisions, the results have been bad. It is by no means certain whether early burning can ever be successfully prescribed for sal forests, other than damp coastal types.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

The marking rules for the Selection Working Circle, Angul division, were provisionally amended. The coppice with standard system was experimentally introduced in certain forests of this division in place of the selection system prescribed. It has been found that under the selection system the local demand for poles is not being met.

Certain minor amendments to the Puri Reserved Forest Plan were made.

(ii) *Yield ; Volume and Form Factor Tables.*

Out of 109 sample plots distributed over five divisions, 3 were abandoned while 2 new ones added during the year. The total number of sample plots at the close of the year was, therefore, 108.

During the year full measurements were carried out in 10 and interim measurements in 1 Sample Plot.

In order to ascertain what rotation will give the highest mean annual increment, volume data were collected over 2-acre Plots in 12, 16, 20 and 24 year old poor thorn type coppice crops in three felling series in Puri division. The results have proved inconclusive owing to differences in topography and soil.

### (iii) *Miscellaneous.*

Phenological data were collected for sal and teak in three divisions.

### (iv) *Forest Entomology.*

Samples of insect attacked young *asan* (*Terminalia tomentosa*) plants, raised in *rab* sowings in Barapahar division, were sent to the Forest Entomologist, Dehra Dun, for identification and suggestion of remedial measures.

## PUNJAB.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

(a) *Propagation of Prosopis juliflora.*—Pods were collected from known parent trees of different forms at Lahore and distributed to divisions and other Government departments. The total collection was 21 maunds, Mexican form 11 maunds, Australian 9 maunds, and the balance of Arid, Peruvian and Argentine forms. Four maunds of Australian form pods were supplied to the Agricultural Chemist, Lyallpur, for carrying out cattle digestibility tests as chemical analysis of the pods revealed that they were far richer in protein contents than common hay and possessed high nutritive value.

12,000 pot plants (Mexican and Peruvian forms) were raised at Lahore and planted over selected mile lengths along the railway line, close to gang huts, and in station yards in various railway sections.

(b) *Treatment of railway embankment at Jhelum.* The work was extended during the year taking up the entire northern face of the embankment. Nearly 1,500' × 32' sloping embankment was revetted, wattled and planted with 16,000 *Agaves* and 13,000 *Ipomœa carnea* cuttings. The plants have mostly established themselves and the embankment has withstood the last monsoon and winter rains.

(c) *Distribution of ornamental plants.*—With a view to encourage tree planting a large stock of ornamental plants was raised in research

nurseries at Lahore and Chichawatni and supplied to various Government departments and public bodies at a nominal cost.

## (ii) *Natural regeneration.*

With the exception of fir zone natural regeneration was generally adequate in the coniferous forests. In scrub areas reproduction from coppice shoots was satisfactory but from seed poor. In irrigated plantations there was no trouble with the reproduction of *shisham* and mulberry in coppice areas. Observations on important species are recorded below :—

*Cedrus deodara*.—In the dry zone natural regeneration was commonly observed under the protective shade of the mother trees. Stocking of regeneration areas presented great difficulty unless the fellings were regulated so as to afford protection from hot sun to the germinated seedlings (Upper Bashahr).

*Pinus excelsa*.—Natural regeneration was abundant in regeneration areas and fire blanks inspite of grazing. In fact *kail* was aggressive in most of P. B. I areas and had to be cut in favour of deodar (Seraj, Upper Bashahr). Observations in research plots in high level *kail* forests as well as in mixed *kail* and fir forests showed distinct improvement in natural regeneration where humus was scraped off or burnt.

*Abies pindrow* and *Picea morinda*.—Assessments of Kulu plots (Research) confirmed the previous years' observations with regard to both the effect of soil treatment and manipulation of canopy, viz., the removal of humus and exposure of mineral soil gave significantly better results ; and the influx of regeneration was inversely proportional to the opening of canopy. Under strip fellings seedlings were more numerous in 50' and 75' strips compared with 100' wide strips and under shelterwood reproduction was distinctly better in 20' × 30' gaps than bigger openings of 40' × 50' or 60' × 70' (Research). Natural regeneration was also observed in Chak ban Kareri where humus layer was thin about 2" deep (Kangra).

*Dalbergia sissoo*.—Profuse natural regeneration appeared in *shisham* bearing riverain *belas* (grassy blanks) during the summer rains but failed to survive even with effective closure. Heavy shade of mother trees, root competition of rank vegetation and prolonged submergence under water were considered to be adverse factors (Depot West). Inducing root suckers by digging trenches up to a distance of 1 chain from mother trees proved useful for stocking blanks in Ludhiana reserve (Upper Bashahr).

*Morus alba*.—Abundant natural regeneration of mulberry was observed annually in riverain areas under open *shisham* crops but it failed

to develop. Grazing and browsing (including *nilgais*) were believed to be mainly responsible for its destruction. Consequently some areas are being fenced to compare results (Depot West).

*Acacia arabica*.—Natural regeneration came up in abundance in riverain areas but was killed outright by frost in the open and survived only in small gaps protected by mother trees (Depot West).

*Acacia farnesiana*.—There has been fair reproduction in riverain areas both from seed and coppice in spite of grazing,—often growing in thickets in hanks to the exclusion of other species (Depot West).

### (iii) Investigation on seeds.

(a) *Seed years*.—It was a poor seed year for deodar (*Cedrus deodara*) *chil* (*Pinus longifolia*) and *phulai* (*Acacia modesta*). The seed crop of *kail* (*Pinus excelsa*), spruce (*Picea morinda*), silver fir (*Abies pindrow*), and olive (*Olea cuspidata*) were moderate, and that of *shisham*, mulberry, *bhan* (*Populus euphratica*) and *kikar* (*Acacia arabica*) plentiful.

(b) *Seed storage*.—Storing *Prosopis* pods in tins with sand layer spread on top failed to prevent the attack of *Caryoborus gonagra*. *Salvadora persica* seed was found to lose germinative capacity on storage for one year and *Ulmus laevigata* seed after 6 months (Research).

(c) *Germination tests*.—Observations on the germinative capacity of seeds and duration of germination were recorded for all species tried in research nurseries.

### (iv) Investigation on seedlings.

(a) *Seasonal height growth*.—Measurements of height growth were recorded in research nurseries. At Chichawatni (irrigated plantation) the incidence of maximum monthly increment was in July-August and growing season from March to middle of November for majority of species but some behaved exceptionally. *Casuarina cunninghamiana* and *lepidophloia* continued height growth all the year round, *Acacia farnesiana* and *Rhus lancea* started growing early in February and continued till the end of November whereas *Prosopis juliflora* (Argentine) and *Schinus molle* attained maximum growth in September last of all.

(b) *Frost injury*.—At Chichawatni the lowest temperature recorded was 26°F. Amongst the new species tried *Cassia auriculata* and *C. javanica* were entirely frozen. *Acacia caffra* and *Tipuana speciosa* also got badly bitten although they did not suffer much during previous years.

(v) *Investigations on trees and crops.*

(a) *Phenological study*.—Observations were recorded for select species (Research).

(b) *Water requirements of Prosopis*.—A plot was laid out in Arafwala plantation to study the minimum water requirements of *Prosopis* in irrigated plantations, particularly to find out if the species could do without irrigation in the months of May-June when water supply was short in plantations (Research).

(c) *Inheritance of characters*.—In the *shisham* inheritance of stem characters (crooked, forked and straight) plots, the progeny of crooked trees was observed to be weak in comparison with the other two forms.

(vi) *Artificial regeneration.*

*Cedrus deodara*.—Patch sowings, done over 17 acres, were doing well (Seraj). 87,422 plants, mostly deodar, were transplanted in regeneration areas and fire blanks (Kulu).

*Dalbergia sissoo*.—Stocking of riverain *belas*\* with *shisham* in conjunction with agricultural crops was undertaken in Depot West Division, and an area of 20 acres was successfully handled. It was found easier to stock sandy loam soils than stiff clay. Stump planting gave better results than sowing. Planting in February-March proved more successful than in July-August but it was only possible where irrigation could be done in the ensuing hot weather (Depot West).

*Eucalyptus rostrata*.—8,804 plants were planted in the regeneration area, Changa Manga plantation, for future standards. No special irrigation or weeding treatment was given but the area was fenced with barbed wire to protect against damage by *nilgai*. Success was 34 per cent. (Tramways).

*Morus alba* and *Melia azedarach*.—Underplanting in *shisham* irrigated plantations was very successful (Montgomery, Multan, Research). Over 1,400,000 plants were under and interplanted during the year (Multan).

*Other species*.—A large number of species were tried both in hills and plains to meet various requirements. To mention a few *Thuja plicata* maintained its success in fir areas (Research). *Cryptomeria japonica* and *Cupressus torulosa* did well in Dharamsala oak forests (Kangra) and *Prosopis glandulosa* proved useful for stocking dry rakhs (Depot West), *kallar*, *rappar* and *khappar*† areas in plantations (Montgomery,

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NOTE.—\* *Bela* is an island in a river and thus naturally subject to submergence under water for part of the year.

† *Kallar* is loose saline soil characterised by salt efflorescence on the surface. *Khappar* is saline soil but harder.

*Rappar* is also saline but very hard and has a shining (silvery) surface.

Multan). *Prosopis juliflora* (Argentine form) did well in poor soil in irrigated plantations and together with Arid and Mexican forms in dry foothill scrub areas. *Agaves* were found highly useful for erosion control (Research).

#### (vii) Nursery work.

Research division nurseries were maintained at Manali, Chichawatni and Sambalpani where culture of exotic and indigenous species likely to be of value for silvicultural, afforestation or counter-erosion purposes was studied and stock raised for research planting and distribution. Besides, big nurseries, both permanent and temporary, were maintained by territorial divisions for local use and to supplement research on important species of local interest.

At Khanewal (Multan) raising mulberry continuously for 3 years over the same area without manuring was noticed to impoverish the soil. The stock showed a fall in quality. In riverain tracts (Depot West) sandy loam soil was found to be best for raising *shisham* stock to obtain stumps. Where irrigation could be arranged seed was sown in February-March as with rains sowings much of the growing season was lost and a greater percentage of stock did not become big enough to produce cuttings for use in the following year.

#### (viii) Reclamation and Afforestation.

Research and demonstration of erosion control work was concentrated in the experimental plot at Nurpur where various species of trees, shrubs, creepers, succulents and grasses notable for quick establishment, fast growth and soil binding qualities were under trial. The plot also furnished demonstration of the methods of gully plugging and afforestation of eroded slopes as well as the value of closure in restoring natural plant cover. After 3 years of closure the growth of grass had tremendously improved and several indigenous plants, e.g., *Dalbergia sissoo*, *Acacia catechu*, *Zizyphus*, *Cassia fistula*, *Dodonaea viscosa*, *Holoptelea*, etc., had made appearance and were gradually covering the ground. Erosion trays were also installed in this plot and the data collected during the year show that run-off and soil losses were several times more from bare ground than from areas under grass and bushes (Research).

Other afforestation and reclamation works carried out during the year include the construction of 93 stone bunds (22,825 c.ft.) in Surla and Bakshiwal forests (Jhelum); gully plugging with brushwood dams in Pahbi (Lahore); the digging of 2,200 contour trenches in Kalachitta forest (Rawalpindi West and Research); the stocking of fire blanks in Nagni and Niaragarh with 8,000 deodar plants (Kulu); the planting

of 'dab' grass (*Eragrostis-cynosuroides*) areas in irrigated plantations with *bakain* (*Melia azedarach*) (Multan, Montgomery) and successful stocking with *Prosopis* of *kallar* and *khappar* areas in plantations (Multan, Montgomery), of Pabbi ravine land (Lahore), dry *rakh* (plains scrub) Dhul (Depot West) and arid scrub areas in Kalachitta (Research and Rawalpindi West).

(ix) *Tending.*

Experiments were laid out (a) to study the effect of heavy cleaning in deodar crops leaving young plants 9' apart (Lower Bashahr), (b) to find out the best thinning espacement for young *chil* pole crops to reduce cost on unsaleable early thinnings, and (c) to determine the suitable intensity of second thinning in irrigated plantations (Research).

(x) *Mixtures.*

To avoid the necessity of early unsaleable thinnings and as a measure of fire-protection experimental interplanting of deodar with broad-leaved species was started in Lower Bashahr. An area of 25 acres was planted with deodar and poplars in alternate patches.

(xi) *Underplanting.*

2,789 acres were under and interplanted with mulberry and *Melia azedarach* (Multan). Experimental underplanting of *shisham* crops with *Celtis eriocarpa* in Chichawatni irrigated plantation was attended with 77 per cent. success. The plants attained a height of about 5' in 3 years (Research).

(xii) *Silvicultural systems.*

Clearfelling in winter followed by trenching in spring proved to be the best method for naturally regenerating *shisham* high forests in riverain areas (Depot West).

(xiii) *Miscellaneous experiments.*

*Bhabar grass* (*Ischaemum angustifolium*).—Experiments in progress in Kalesar reserve indicated that yield could be appreciably increased by planting grass tufts after heavily opening the canopy leaving about 5-7 trees per acre. Weeding promoted the spread of grass but the gain was not commensurate with the cost (Simla).

*Record of ground flora in chil and kail forests.*—Study is in progress on the succession of vegetation in fire blanks in *kail* forests (Lower Bashahr) and on the effect of departmental burning on ground flora in *chil* forests (Research).

## II.—WORKING PLANS AND STATISTICS.

*Working plans.*—The position with regard to new plans is as under :—

*Working plans published for :—*

- (i) Simla Municipal Forests ; and
- (ii) Pahbar Valley Forests, Lower Bashahr.

*Working plans in press, for :—*

- (i) Changa Manga plantation ;
- (ii) Daphar plantation ; and
- (iii) Throach State Forests.

*Working plans and schemes under preparation, for :—*

- (i) the riverain *belas* on the Chenab and Jhelum rivers ; and
- (ii) Forests of Rawalpindi East division.

*Sample plots.*—Sets of properly replicated comparative thinning plots were laid out in young *chil* crops at Panjar and in *shisham* crops at Chichawatni. 57 plots were remeasured, of which the 9 *shisham* plots in Lahore and Montgomery divisions were clearfelled and fully measured. Datum boards containing crop data figures at successive measurements were posted in all the sample plots in Rawalpindi East and West divisions.

*Preservation plots.*—There are 44 on the provincial list covering the main forest types in the Province. One plot was added during the year.

*Shisham espacement plots.*—Planting espacement experiment initiated at Chichawatni in 1928 was closed during the year. Results indicated that closer espacement i.e., 5'×10' and 6'×10' gave higher outturn than 8'×10' or 10'×10' planting, besides being useful in controlling weed growth.

*Single tree data.*—Summary results of data collected in the course of sample plot measurements and compiled at Dehra Dun were posted in Form 10. Hill divisions also contributed in the collection of data for standard volume and commercial outturn from their felling coupes.

### *Miscellaneous.*

*Rainfall data.*—Rainfall statistics collected in the territorial divisions were maintained and a consolidated annual statement prepared (Research). A rain gauge was installed at Bashla (Lower Bashahr).

*Photo collection.*—A substantial addition was made during the year. The collection as it stood at the end of the year was 1,608 negatives, 2,393 prints and 343 lantern slides (Research).

*Records.*—Two specific and seven general files were opened. The total number now stands at 156 specific and 334 general files (Research).

*Library.*—153 new publications were added over and above serial bulletins and periodic literature on forestry subjects (Research).

*Exhibition.*—With a view to educate the public on forest matters a forestry pavilion was opened in the All-India Exhibition of Arts and Industries held at Lahore in December 1937. Exhibits included erosion, forest working and Punjab forest type models and various forest products which could form the basis for the development of cottage or large scale industries. Over 3 lakhs of people visited the pavilion in the course of two months and many of them displayed a keen interest in the development of forest industries (Research).

*Museum.*—Steps were taken to enlarge and bring up to date the forestry section in Lahore Museum. Forestry models after display in the exhibition were also transferred to the museum. Work in the museum was in progress at the close of the year (Research).

*Erosion propaganda.*—Since erosion constitutes a problem of great magnitude in the Province a special forest ranger was attached to the Commissioner, Rural Reconstruction, Punjab, to enlighten the public as to its causes and evil effects by displaying erosion models and delivering lantern lectures. Beside eight talks on erosion and forest conservancy were broadcast from the Lahore Radio Station (Research).

*Staff.*—Dr. R. M. Gorrie was incharge of the division for 10 months and Mr. I. D. Mahendru for 2 months. For the rest of the year Mr. Mahendru remained attached to the division working as general assistant. Mr. R. S. Chopra remained attached to the division incharge of sample plot measurements and research work at Chichawatni and Sambalpani.

Bh. Gurbachan Singh, Forest Ranger, was incharge of works in Kulu and Mehta Gurdas Mohan, Forest Ranger, of works in Nurpur and Lahore. L. Chaman Lal, Forest Ranger, was attached to the Rural Reconstruction department for erosion propaganda and miscellaneous duties at headquarters.

## UNITED PROVINCES.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) General.

In order to review the whole range of experiments the research programme was extended for another year before drawing up a new

programme. Accordingly fifteen old experiments were closed down, three transferred to the list of preservation plots and forty were being actively maintained at the end of the year compared with fifty-eight at the close of the previous year.

The most important experiments deal with the natural regeneration of sal. Research and experimental work on this will continue for some years to be of the greatest importance.

## (ii) *Natural Regeneration.*

### (a) From Seed.

2. *Shorea robusta* (sal).—A considerable amount has already been written concerning the development of whippy shoots and woody plants when given adequate overhead light and protection from damage by browsing and weed competition. It seems to serve no useful purpose to say much more about this now. Experiments in hand will continue and conclusions can be drawn when the experiments are closed and finally written up.

The natural regeneration experiments in Haldwani, Ramnagar, Pilibhit and North Kheri continue. The most important work has been the felling carried out over regeneration in Haldwani experiment No. 18. Parts of both the originally heavily felled and the moderately felled areas have been finally felled over. For the purpose of comparison regarding the development of the sal regeneration, of the grass and weeds and of the extent and cost of subsequent rains shrub cutting, only half the overwood was felled. In both the clearfelled and half felled areas comparable plots were laid out to test the value of lopping before felling. The routine measurements of indicator lines and of clear-weeded plots, burning, shrub-cutting and weeding were carried out according to plan.

The value of intensive rains shrub cutting and grass cutting where it interferes with young sal regeneration is illustrated not only by the success obtained when it has been properly done, but also by the distinct lack of progress in an experiment (Pilibhit experiment No. 5) where it had been neglected. It is also interesting to note that rains shrub-cutting is being successfully adopted on a fairly large scale in regeneration areas in the Haldwani, Ramnagar, and Tarai and Bhabar Estates forest divisions, and where seedling regeneration exists this is undoubtedly the best way to get it up.

The study of individual seedlings in the large fenced experiments to which reference was made last year was found to be impractical and has been discontinued.

3. Where regeneration has still to be obtained, the exact method to be adopted cannot yet be laid down. But the progress towards regeneration in some plots of Haldwani and Ramnagar experiments, where regeneration was initially either scanty or absent, has of late been very encouraging to indicate that the experimental work is on correct lines towards the solution of the problem. No success has so far been obtained in obtaining and establishing regeneration in danip evergreen areas. The question of obtaining and establishing sal regeneration *de novo* continues to be the most important item in our programme.

#### (b) From Coppice.

4. *Acacia arabica* (*babul*).—The *babul* coppice experiment has now been closed. In spite of a mild frost and good rains last year, high mortality continued. Climatic and soil conditions, coupled with animal damage, in the Etawah ravines are such that *babul* coppice growth cannot succeed.

5. *Hill oaks*.—*Quercus incana* (*banj*).—The coppice at Bhowali continues to do well. It was freed from suppression by natural *Pinus longifolia* (*chir*), which had come in abundantly following protection from fire and grazing. The *Quercus dilatata* (*tilonj*) and *banj* coppice near Kilberry has developed poorly, chiefly owing to browsing and weed competition, and the experiment has now been closed. The *Quercus lanuginosa* (*rianj*) coppice plot has been constituted as a sample plot.

6. *Acacia catechu* (*khair*).—It was noticed in the Tarai and Bhabar Estates forest division that *khair* trees (even large ones over 16" diameter at breast height) produce coppice shoots if the roots were wounded below ground level after felling. Protection from browsing is necessary.

#### (iii) Seed supply.

7. The United Provinces seed store at Clutterbuckganj continued to collect, distribute and arrange for seed for indentors both within the United Provinces and outside. *Acacia catechu* (*khair*) seed predominated (39½ mds.), with Burma teak seed next (32 mds. 3 seers), together with cleaned mulberry seed (19 mds.), *Dalbergia sissoo* (*sissu*) (15 mds. 35 seers), Bamboo (1 md. 35 seers) and others.

As usual, germination tests of various species were continued at Clutterbuckganj. It is proposed to publish the analysis of results obtained to date in the form of a bulletin or leaflet.

#### (iv) Nursery work.

8. The Clutterbuckganj and Haldwani nurseries were maintained for plantation supply, germination tests and preliminary small scale

experiments. Great success has followed the sowing of South African grass seeds (*Digitaria sericata* and *Digitaria peutzii*) in the Clutterbuckganj nursery, and the grasses are being further propagated to raise stock for large scale sowings and plantings in the *taungya* area. Root stocks of various South African grasses, however, have not developed well.

*Pinus caribæa* seedlings continued to persist although there was considerable mortality probably due to excessive watering.

#### (v) Artificial Regeneration.

9. *Acacia catechu* (*khair*).—It has been definitely shown in the Tarai and Bhabar Estates forest division that *khair* cannot be successfully raised without rains weedings.

10. *Pollinidium angustifolium* (*baib* or *sabai*).—The Ujhani experiment on sandy soil has now been closed as the soil and climatic conditions (frost and drought) proved inimical to the growth. The *baib* plots were, however, quite successful, producing a yield of  $21\frac{1}{2}$  mds. per acre, although the spacing was  $3' \times 3'$ , which has elsewhere been found to be too wide a spacing.

11. In the South Kheri and Pilibhit divisions of the Eastern circle the *baib* plantations continue to be very successful except in the latter division on unsuitable areas. Some plots in South Kheri have produced as much as 58 mds. per acre. The experiment to determine the optimum spacing continues. Indications at present go to show that best results are produced with a spacing of  $2' \times 2'$ .

12. *Tectona grandis* (*teak*).—There was no frost damage during the year in the all-India teak seed origin experiments. The Haldwani plots were thinned just after the close of the year and the question of laying out sample plots will be considered next year.

13. *Santalum album* (*sandal*).—Cuttings made from *sandal* thinned out of old clumps were placed four each round fresh *Lantana* clumps. They have mostly sprouted and developed well. Cuttings put out round bamboo clumps in the Haldwani nursery have mostly not developed, due apparently to excessive shade.

In Jhansi there was a fair recruitment of *sandal* seedlings. Six seedlings of the year grown with host plants in bamboo pots were planted out, but the seedlings died.

14. Artificial regeneration on a large scale continues to be a routine measure in many divisions both with and without *taungya*.

#### (vi) Reclamation and Afforestation.

15. *Usar*.—The Makdumpur experiment was kept closed to grazing during the year. The yield of dry grass averaged  $13\frac{3}{4}$  maunds per acre,

the best plot yielded 21 maunds per acre. A scheme has been prepared to reorganize this experiment, laying out a new one along side, and allowing controlled grazing in both. The present experiment will then shew what incidence of grazing a protected *usar* area can stand without deterioration, and the new one what incidence, compatible with improvement, can be allowed *ab initio*.

16. *Bhur*.—Provided the sand grains, which chiefly compose a *bhur* soil, are fine rather than coarse in texture successful afforestation depends more on climatic conditions than on the soil itself. In the Ujhani and Faridpur experiments both frost and drought have prevented the successful development of all the tree species tried. In such areas in the plains *Pollinidium angustifolium* (*baib*) is the only thing with which any real success has been achieved.

#### (vii) *Tending*.

17. In the Dehra Dun division there are some thousands of acres of sal sapling crops mostly the result of cutting back advance growth. Sets of comparative thinning plots with three different intensities were laid out by the Central Silviculturist, to study the optimum intensity for thinning such crops.

#### (viii) *Mixtures*.

18. The question of mixtures in the Saharanpur *taungyas* continues to receive attention. It has been found that species that are readily browsed are considerably damaged when the cultivators leave the area. Mixtures of such species with others that are thorny or are not readily browsed are being tried.

#### (ix) *Underplanting*.

19. A number of underplanting experiments have been in progress in the Clutterbuckganj *taungya* area. These have shown that mulberry develops best when there is not too much overhead shade; it has done well under *Dalbergia sissoo* (*sissu*) and open *Acacia catechu* (*khair*), but poorly under heavier *Acacia catechu* (*khair*) shade. Both sowings and cuttings of various sizes have developed well. *Eugenia jambolana* (*Jaman*), on the other hand, has done poorly wherever tried in open areas, but has developed well under heavy *khair* shade. *Holoptelia integrifolia* (*kanju*) which did poorly under light *Acacia catechu* (*khair*) and was subsequently replaced by mulberry, has developed well now that the *khair* canopy has closed up, and is suppressing the mulberry put out to replace it.

(x) *Silvicultural Systems.*

20. Nothing special to report.

(xi) *Miscellaneous.*

21. In the resin tapping experiment at Garkhet in Almora a fresh series of channels was begun. These channels will be tapped for a second year then the experiment will be closed and written up.

The propagation of *Saussurea lappa* (*kuth*) at 6,000' near Garkhet was practically a failure. Germination was good but mortality due to drought considerable.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

22. Working plans for the Naini Tal and Saharanpur forest divisions and for the Muktesar Institute and Ranikhet Cantonment forests were completed during the year. Working plans were in preparation for the Lansdowne, South Kheri and Garhwal forest divisions and the Lansdowne Cantonment forests. Preliminary working plan reports were written for the Garhwal and Dehra Dun forest divisions and the Naini Tal Municipal forests.

(ii) *Yield Tables.*

23. Eighty permanent sample plots were re-measured in the Chakrata, Ramnagar, Kalagarh and Silviculture divisions. Owing to the unexpected transfer of the Assistant Silviculturist some sample plots in Lansdowne division could not be remeasured. The first remeasurements of the linear sample plots in Ramnagar and Kalagarh divisions were done this year, and the data have now to be statistically analysed.

(iv) *Miscellaneous.*

25. Bulletin No. 10 "The Taungyas of the Saharanpur Forest Division" was issued during the year.

Over 500 photographs, received from the Central Silviculturist, were added to the Provincial collection.

26. The Silviculturist gave ten lantern lectures (besides several informal lantern shows) to different schools and colleges in some important places of the province. He was appointed secretary of the United Provinces Standing Fodder and Grazing Committee.

27. The staff employed on silvicultural and statistical research work consisted of the Silviculturist, the Assistant Silviculturist (for part of the year), one forest ranger, one deputy ranger and three foresters.

## CHAPTER III.

### FOREST BOTANY.

#### ASSAM.

##### I.—OECOLOGY.

During the year under review little progress could be made in the collection of specimens from the *Sal* Forests of Goalpara for the detailed study of the different kinds of vegetation and its oecological association. This is a matter which must await better times. As mentioned by Dr. Bor, in the last report, it is hoped that the officer-in-charge of the revision of Goalpara and Kamrup Working Plans will be in a more convenient position to be able to collect data for this very important work.

The botanical investigation in the newly explored forest tract opened up with the construction of the Sylhet-Shillong road was continued and the specimens collected were separately stocked for examination in order to find out the important species.

Dr. Bor who was keenly interested in the relict forest of the Khasi and Jaintia Hills (*vide* last report) made an intensive collection of plants of the Shillong Plateau in order to determine what was the actual climax forest of these hills above 4,000 ft. His publication on the subject is being awaited with much interest.

##### II.—SYSTEMATIC.

##### *Herbarium work and other investigations.*

The new *Eugenia* found in the Sadiya Frontier Tract by Mr. Purkayastha has been named *Eugenia assamica* Bis. et Purk.

The description of a new species of *Phæbe* which has been published in the "Science and Culture" as "*Phæbe assamica*" Kalyan Kumar is reported to occur in the Sadiya Frontier District. Enquiries are being made regarding the availability of the type sheet of the species for reference and collection of materials for herbarium record.

The herbarium has been maintained in good condition. Marked progress has been made in mounting specimens. About 5,000 sheets have been properly mounted and 4,000 specimens have been added and laid into the herbarium. Very little touring for collection outside

the nearer areas in the Khasi and Jaintia Hills was possible for want of requisite staff and for funds. Activities had been chiefly confined to areas in and about head quarters and have been directed to keeping the permanent collections in a proper state of preservation and storage, to deal with material already accumulated and awaiting attention, answering the various references that are normally directed to the Department and to push on the publication of Volume II of the Assam Flora.

Throughout the year ungrudging assistance was rendered by the staffs of the Royal Botanic Garden, Kew and of Sibpur and the Forest Botanist, Dehra Dun in many directions for which they deserve our best thanks.

A fair amount of identification work was carried out locally for the herbarium and for Divisional Forest Officers. The work of poisoning the collections was also continued as far as practicable by the existing staff.

Duplicate herbarium sheets were received as follows :—

Forest Research Institute, Dehra Dun . . . . .	5 sheets.
Forest Research Institute, Fed. Malay States . . . . .	24 sheets.
Royal Botanic Garden, Sibpur . . . . .	1 sheet.

Duplicate Herbarium sheets were supplied as follows :—

Forest Research Institute, Dehra Dun . . . . .	12 sheets.
Royal Botanic Garden, Kew . . . . .	7 sheets.
Dr. E. K. Janaki Ammal, Geneticist, Imperial Sugarcane Station, Coimbatore . . . . .	3 sheets.
Royal Botanic Garden, Sibpur . . . . .	12 sheets.

Conservator of Forests, Forest Research Institute, Kepong, Selangor, Fed. Malay States . . . . .	Complete fruiting material of <i>Shorea assamica</i> .
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The following herbarium materials were lent to other persons and institutions, etc. :—

Health exhibition stall, Shillong . . . . .	44 specimens of indigenous medical plants of Assam were exhibited with details recorded thereon for the Health Exhibition held at Shillong from 1st to 5th April 1938.
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Seeds of the following species were received as follows :—

<i>Pinus longifolia</i> . . . . .	} Silviculturist, U. P.
" <i>exelsa</i> . . . . .	
<i>Eucalyptus globulus</i> (blue gum) . . . . .	Silviculturist, Madras.
<i>Barris elliptica</i> . . . . .	State Agricultural Officer, Selangor, Fed. Malay States.

Seeds or roots, etc., of the following species were supplied as follows :—

<i>Shorea asamica</i> (seeds)	Conservator of Forests, F. R. I. Fed. Malay States.
<i>Morinda umbellata</i> (root)	Dr. R. Pfister, Guimet museum, Paris.
<i>Eveaia roxburghiana</i> (root bark)	Forest Botanist, Forest Research Institute, Dehra Dun.

Exchange relations were continued with the following and publications and herbarium materials were received and distributed mutually :—

- (1) Prof. S. P. Agharkar, Head of the Botany Department, University College of Science, Calcutta.
- (2) Director of Gardens, Straits Settlement, Singapore.
- (3) Forest Botanist, Forest Research Institute, Kepong, Selengar, Fed. Malay States.
- (4) Prof. T. Tanaka of the Imperial University Taihoku, Formosa, Japan.

Various enquiries of scientific and economic importance were dealt with by this herbarium through the Conservator, Divisional Forest Officers, Institutions and other concerns in and outside India.

The herbarium continues amply to justify its existence locally and also to scientific Institutions in India and in other parts of the world. It is being more usefully used by the Forest Utilisation Officer, Assam, than anybody else for information in connection with development of the trade in various articles of minor forest produce. An account of the herbarium was supplied in connection with the last session of the Science Congress held in Calcutta in January 1938 for its inclusion in the account of the discussion on a National herbarium.

### Staff.

The post of the Botanical Forest Officer was held by Dr. N. L. Bor, Deputy Conservator of Forests, till the afternoon of 10th October 1937 when Mr. R. N. De, Deputy Conservator of Forests took over and held the charge for the remaining period of the year.

All the members of the staff worked well during the year. It is a pity that they have been in the temporary establishment for a very long period although the proposal for their confirmation was accepted by the Government in 1935 and was passed by the Council in 1936. In the best interest of the Department and the public alike, the permanency of the staff is urgently called for. Loyal and honest work cannot be expected from a discontented staff for long.

### III.—PATHOLOGY.

The attack of a fungus is exceedingly common in the Short-round pine forests of Shillong manifesting itself in a cankerous or tumour-like

growth on the stem or the branch. In the æcidial stage, yellow pustule-like fruiting bodies appear on the bark covering the tumour. A specimen of the fungus has been sent to the Forest Research Institute, Dehra Dun, for examination.

*Sissu* (*Dalbergia Sissoo*) seedlings in the Nonoi plantation of the Darrang Division were suspected to have been attacked by a fungus and the Botanical Forest Officer collected some specimens, which were sent to Dehra Dun, for examination. It transpired that some of the young terminal shoots were attacked with fungus with fructification of a *Phoma* sp. which causes wilting followed by death to the affected parts.

#### IV.—PUBLICATIONS.

Volume II of the "Flora of Assam" and Assam Forest Records, Volume II (Botany) edited by Mr. A. Das, I.F.S. (Retired) consisting of several species of *Phæbe* and the 4 new species mentioned in the last report were published during the year.

Collection of materials for the revision of the list of known poisonous plants of Assam was continued.

A list of indigenous medicinal plants of Assam was drawn up for the herbarium exhibits displayed in the Shillong Health Exhibition held in March 1938.

Revision of the manuscript of Volume III of "Flora of Assam" (*Gamopetalae*) was practically completed and made ready for the press.

#### BENGAL.

Collection of specimens of doubtful or unknown plants was continued and sent to the Forest Botanist, Forest Research Institute, Dehra Dun, for identification. Herbarium specimens of *Betula* species from Kalimpong Division, were sent to Dr. J. M. Cowan, I.F.S. (Retired), Royal Botanic Garden, Edinburgh.

#### *Forest Mycology.*

Dr. K. D. Bagchee, Mycologist, from the Forest Research Institute, Dehra Dun, visited Buxa Division, in connection with his investigation of the fungi attacking *sal* trees and specimens were collected and sent to Dehra Dun in this connection.

#### BIHAR.

##### I.—ECOLOGY.

##### *Soil moisture Tests.*

*Irrigated Vs. Un-irrigated land, Namkum.*—Through the courtesy of the Director, Lac Research Institute, and with the active co-opera-

tion of the Entomologist, soil samples were taken on 25th April 1938, at 1', 3' and 6' levels on ordinary and contour trenched land in the Namkum Lac Orchard near Ranchi. The moisture percentages were worked out in the Institute's laboratories.

The orchard 85 acres in extent, faces West with trees 12'-20' apart according to species, on gently sloping land with practically only one gradient and with canopy at present incomplete especially after pruning takes place. The soil, a deep loam, is admirably suited for soil moisture tests. The two areas as far as could be observed were strictly comparable. The general appearance of the lac host trees was better on the unirrigated plot than on the irrigated area.

The 9 acre irrigated area was laid out with contour trenches 2' or more deep by 2' wide at 35 yard intervals down the four hundred yard slope at the beginning of the previous monsoon. The trenches were sufficiently deep and sufficiently close to each other to ensure that every drop of the monsoon rain water was held up, except at the bottom where the slope eased off and clay was met with, at the 3' level. Here water overflowed the trench. The tests were taken at the driest and hottest time of the year after a severe dry April. No rain had fallen for at least six weeks. No. 1 soil pit was dug at the top of the slope between the 1st and 2nd trenches, No. 2 midway down the slope and No. 3 at the bottom just below the last trench. Nos. 4, 5 and 6 pits on the non-irrigated areas are comparable in situation to Nos. 1, 2 and 3 pits respectively.

Both the irrigated and the non-irrigated areas had a grass cover which helped to prevent evaporation, though this cover was only one year old and not fully complete.

Soil moisture percentages are of little value, unless, they can be interpreted in terms of the growth yields which may be expected. No growth yields are available for tree species for different percentages of soil moisture, as the difficulties which surround such an experiment are well nigh insuperable except perhaps for very small trees, but growth yields for barley (and for wheat at a later date), were worked out as long ago as 1883 by Hellriegel (Russell's Soil Conditions and Plant Growth) on sand pot cultures. As plant growth under semi arid conditions is largely determined by and almost proportional to the amount of water available in the soil up to 60 per cent. of saturation (Russell), these yields have been used to indicate the extra amount of growth which one might possibly obtain from the extra moisture available in the irrigated area.

The results are given below in tabular form :—

*Examination of soil moisture on ordinary and contour trenched land at the Namkum Lac Orchard ; soil samples taken on 25th April, 1938.*

UNIRRIGATED.					IRRIGATED.							
Pit No.	Depth at which sample taken.	Moisture percent- age.	Remarks.	Yield from Barley growth curve.	Pit No.	Depth at which sample taken.	Moisture percent- age.	Remarks.	Yield from Barley growth curve.	Difference in moisture content between irrigated and un- irrigated land.	Difference in yields— irrigated minus unirrigated areas.	Predicted per cent. increase of growth yield in irrigated areas, (from Barley growth curve).
				Total.					Total.			
4	1'	7.80	Nil	.8	1	1'	8.11	Nil	1.1	.81	.8	87.50
	3'	11.04	Nil	4.1		3'	12.81	Nil	5.2	1.27	1.1	26.82
	6'	7.03	Containing mostly stones.	.7		6'	12.55	Containing a few pieces of stones. (iron pan).	5.7	5.52	5.0	714.28*
5	1'	8.95	Nil	1.7	2	1'	10.49	Nil	4.7	1.54	3.0	176.46
	3'	7.40	Containing mostly stones.	.9		3'	13.53	Nil	6.7	6.13	5.8	644.44*
	6'	9.88	Containing of few pieces of stones.	2.9		6'	13.54	Nil	6.7	8.66	3.8	131.08*
6	1'	5.99	Nil	.4	3	1'	8.31	Nil	1.2	2.32	.8	200.00
	3'	11.82	Nil	4.6		3'	14.08	Nil	7.3	2.26	2.7	58.69
	6'	7.16	Containing mostly stones.	.8		6'	13.18	Containing & few pieces of stones. (iron pan).	6.2	6.02	5.4	675.00*

\* These results cannot be compared with their opposite numbers in pits 4, 5 and 6, owing to the presence of stones in the samples.

Unfortunately some of the samples contain stones which preclude their comparison with their corresponding opposite numbers. Thus none of the 6' level samples can be compared nor can the 3' levels in pits Nos. 5 and 2.

The first thing to notice is that all the irrigated samples without exception show higher moisture values than the un-irrigated ones.

Secondly, that for the five samples which are comparable, the predicted increase in growth is significant, ranging from a 26 per cent. minimum to a 200 per cent. maximum, this in the driest time of the year, when growth in trees begins. Khair (*Acacia catechu*), palas (*Butea frondosa*), and ber (*Zizyphus jujuba*) are all pruned in the period March-May for the July or the October-November infection of the new young shoots, so that the value of the extra stimulus to growth which contour irrigation gives to these new shoots can be appreciated—the bigger and more succulent the shoot is by the time of infection, the greater will be the feeding ground for the lac insect and the greater the expectation of a subsequent heavy lac yield, though naturally the extra yield of lac may not necessarily equal the extra tree growth yield, as other extraneous factors can intervene.

As moisture content, and consequential increase of growth is higher at all soil depths on the irrigated area, it also follows that not only the lac host trees tapping the lower levels but also the grass soil cover tapping the upper levels will benefit. Increase of grass will give an increase of humus decay, if as in this case, the increased yield will not all be reaped as hay, resulting in an increase in the organic compounds of nitrogen, phosphorus, and potassium which will be carried down in solution into the soil for extra benefit to both crops. The increased grass crop will also help to prevent soil losses by erosion.

Another point to note is that in the case of soil pits 1 and 3 the few pieces of stone met with at the 6' levels were accretions in an iron and alumina pan. Their presence has made little appreciable difference to the moisture content as compared with the 3' levels whereas in soil pits 4, 5 and 6 the stones were part of a gravelly sub-soil—which has caused a serious drop in the moisture content.

It illustrates the fact that provided the iron pan is not impenetrable, it does not hinder tree growth, whereas a gravelly soil by draining away and so lowering the soil moisture content is a hindrance.

It is also possible that irrigation may take the iron pan down to a lower level, but as the conditions under which pan is deposited are very variable it would require a long and careful investigation to ascertain the effect of irrigation on the depth of pan formation in this case.

On the other hand, if the un-irrigated land were to be irrigated the increased moisture content of the soil would cause a more rapid weathering of the gravelly subsoil of gneissic origin by the disintegration of the feldspars into clays.

While the abnormally dry April weather has affected the moisture content of the 1' depth samples, the 3' levels and the 6' levels do not appear to have been effected much, in fact, they are very nearly in equilibrium as is illustrated by the irrigated plots. This explains why trees can put forth leaves in the hottest and driest time of the year, as their moisture reserves are drawn from the lower soil levels.

Finally it is of interest to note that the moisture percentages of the 3' and 6' levels of the irrigated areas, increase in the middle and lower pits as compared with the upper pit. This is attributed to seepage of surplus water from above so that a better growth may be expected as one descends the hill, if other soil conditions remain the same.

Soil samples are to be taken again in July, and at the end of the monsoon rains, in order to obtain a complete picture of the effect of contour trenching upon moisture content at different times of the year.

*N.B.*—The above report has been corrected to conform with helpful criticism made by the Director of the Bureau of Soil Science, Harpenden, England.

*Santara 15, and Pogamara gara (Bamiaburu irrigated area) and Protected Forest 25 and Ankua 4, near Salai (controls).*

The object of these tests taken between the 19th and 21st May 1938, when the *sal* seeds were falling, was to discover whether better conditions for their germination prevailed in the irrigated area or without it in former comparable areas. Also to discover if irrigation increased the moisture content of the soil at lower depths,—sample scrapings of not more than  $\frac{1}{4}$ " depth, of the soil were tested for moisture content to prove the former, and samples at lower depths for the latter.

Difficulty was experienced both in the irrigated area and in Protected Forest 25 in finding areas having a good depth of soil free from stones or rock, as these would upset the tests. Eventually a pit was dug, 133 yards from the trench in Pogamara gara and another in Santara 13, 43 yards from the trench just above the Research Thinning Plots, but samples could only be taken up to 2' depth. In Ankua 4, the soil was deeper. Preceded by lighter showers earlier in the month, .4" rain fell on the 12th May at Bamiaburu, and another heavy shower of .5 inch on the 16th instant, just after the areas there had been selected. As under normal conditions Salai would expect to get quite as much rain, if not more than Bamiaburu, from its proximity to the high hills of Duia and Indian Iron Mines in the East and Budha Buru in the West, all well over 2,000', if Bamiaburu received more rain from these

two storms than Salai, it is due to the experiment, not to its more favourable topographical position. In fact, the storm of the 16th came from the Salai direction, where it had rained. It is also reported that a light shower fell on the 20th evening at Bamiaburu, before the second soil scrapings were taken in the Pogamara gara and Santara 13.

Care was taken in the selection of each site, especially in the control areas, to see that the ground was well covered with grass which would retard evaporation to give a high moisture value.

The results of the soil moisture tests are shown below :—

*Percentage of soil moisture.*

	Control Plots.		Irrigated.	
	Protected Forest 25.	Ankua 4.	Pogamara gara.	Santara 13.
Surface scraping	8.9	4.8	18.4 (19th May) 16.6 (21st May)	16.1 (19th May). 13.3 (21st May).
1' . . .	11.9	12.6	16.8 . .	12.9
2' . . .	13.8	13.8	13.8	16.0
Date on which samples were taken.	20th May, 9 A.M.	20th May, 8 A.M.	19th May, 9 A.M.	19th May, 10 A.M.

The chief thing to notice is the comparative dryness of the surface scrapings of the control plots, especially those of Ankua 4. An inspection of the road surface nearby, seemed to show that the ground had received only a little rain from the storm of the 16th.

On the other hand the Pogamara gara and Santara 13 surface scrapings show high moisture contents, higher than the samples at 1' and 2' depth. These high moisture values were due to the rains already mentioned. While digging the pits it was noticed that the rain had penetrated the first 4"-5" of the soil. It is interesting to note that the moisture values of the 21st May are lower in both cases than those of the 19th. This is probably due to the last evaporation which occurred between the 19th and 21st, with only a very light shower (.03 inch) on the 20th evening, to counteract it.

The lower surface scraping moisture values for Santara 13, as compared with Pogamara gara, may be due to taking the samples one hour later on the same day with an hour's extra sun drying the surface.

The results show that the conditions in the trenched areas of Bamiaburu were much more favourable for germinating the perishable sal

seeds than were the conditions in Protected Forest 25, and Ankua 4. The moisture contents would scarcely be high enough to germinate the seeds (germinating tests for seeds are carried out on soaked blotting paper), but, once the showers which were falling fairly frequently at the time, had started the germination, there would be sufficient moisture in the soil to enable the seed to take root.

The Divisional Forest Officer records that it rained every day after the 21st for the week he was there, so that conditions for seed germination became even more favourable than at the time of the experiment. In Chota Nagra, no rain fell between the 20th and 23rd, when a heavy shower fell. Thereafter, it would seem that the rainfall throughout the Singhhum forest area became general.

As regards the samples taken at the 1' and 2' levels there is nothing striking to observe except the 2' level of Santara 13, which records 16 per cent. moisture. This may be due to the fact that the pit was only 43 yards from the trench, whereas the Pogamara gara pit where 13.8 was registered was further away. On the other hand, the level of the Pogamara gara shows a high percentage moisture 16.6 at the 1' level, with an inexplicable drop to 13.8 in the 2' level. It would almost seem as if the results for the 1' and the 2' levels should be reversed to be more consistent with the Santara 13 records.

It will be necessary to repeat these records, especially for the lower levels.

## II.—SYSTEMATIC.

### *Palamu Division.*

In plantations from seeds of chir pine (*Pinus excelsa*)\* two kinds of pine were noticed, the leaves and cones of one being longer than those of the other. The former is true *P. longifolia*, the identification of the latter is still under investigation at the Forest Research Institute, Dehra Dun.

## III.—PATHOLOGY.

Fungal diseases in sal in Singhhum forests are extremely common, especially in the drier Hill Sal areas. There is a great prevalence of unsoundness and heart rot while dead trees are a common phenomenon. Examination suggests that not only is the heart rot due to fungal attacks but also the deaths.

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\*The tentative identification of *Pinus excelsa* was given on a specimen without cones taking into consideration the Wood Technologist's opinion that the wood resembled that of *P. excelsa*. Since then however complete specimens prove that the identification is not correct and that the pine is certainly not *P. excelsa*. The cone and leaves cannot, however, be matched at Dehra and are being sent to Kew. The D. F. O. has sent complete timber samples of the two species and these are being investigated.

During the last 2 or 3 years specimens of fungal sporophores have been sent to the Research Institute at Dehra Dun and requests made for a Mycologist to be sent to Singhbhum for examining unsoundness and mortality in sal. Dr. Bagchee, the Mycologist at Dehra Dun, accordingly toured in Saranda, from the 23rd January to 3rd February 1938, and then went to Kolhan division.

Dr. Bagchee has not yet drawn his report on the fungal attack on sal trees of Singhbhum forests. Mr. F. C. Osmaston, the Divisional Forest Officer, Saranda, who accompanied Dr. Bagchee in his tour writes as follows :—

“A full report cannot be made for some time as much will depend on the results of cultures to be taken from specimens collected, while a final report can only be made after cultures have successfully been infected into sound sal when only can the life history of each fungus be satisfactorily ascertained.

In Saranda, unsoundness seems to be worst on white shale soil where sabai grass is usually common and this unsoundness is perhaps accentuated if there are signs of previous cultivation. Unsoundness is least prevalent on those red soil slopes, so often lateritic or derived from iron ore beds. In such areas unsoundness may be as little as 10 per cent. say, while in had shaley soils it may be as high as 75 per cent. or more. In deep soiled valleys (unless in white shales), especially red soils, unsoundness is usually not pronounced unless the trees are very old. (Lateritic soils are indicative of high rainfall and the fact that unsoundness is least on them seems to suggest that unsoundness is correlated with drought. Ed.)

Mortality is often most noticeable in mature stands of good quality where the soil is a dead red loam.

In Saranda there seem to be 3 main active fungi that cause death or unsoundness. These are (as far as Dr. Bagchee could confirm):—

- (i) *Polyporous shoreæ*.
- (ii) *Fomes tricolor*.
- (iii) *Trametes incerta*.

*Polyporous shoreæ*.—This is the sal root fungus, which rots the root system, eventually causing death but does not necessarily cause unsoundness as it advances only slowly up the stem. It is mainly responsible for deaths of sal. It appears to develop best in deep soils where quality is good and to kill large trees. Dr. Bagchee in the field failed to find any rhizomorpha. Infection may be due to wind dispersal of spores only or to contact by infected roots as well.”

The Conservator is of opinion that *Polyporus* is definitely a fungus of rich deep soils where sal thrives well and is more prevalent in loamy soils. It generally attacks either isolated trees or groups at once and that death takes place within 2 rainy seasons. Healthy trees and poles are attacked and killed outright. The attack broadens gradually from a centre but does not interfere with young regeneration.

*Fomes tricolor*.—This fungus is very common and is found in all types of sal forest in Saranda, though it is undoubtedly least common in the red iron soil slopes. It seems to be a heart rot and perhaps only a heart rot, and so may not be concerned in the death of a tree. On the other hand it seems to advance from the root upwards. It may be one of the causes of dry rot in sal timber and to be capable of spreading after timber is felled and converted to sleepers or scantlings.

It is also possible that it enters a tree through the stems and proceeds downwards. For example saplings and young trees often have a knotty appearance with multitudinous epicormic branches. There is some evidence that rot enters and develops down the stem from these knots.

*Trametes incerta*.—This fungus seems to be a heart rot only and one that does not kill a tree. It appears to be more local than either *Polyporus shorea* or *Fomes tricolor*. It seems mainly to frequent white shaly solid localities where sabai grass is plentiful.

Attacked trees seem to have a crooked appearance with knotty protusions from which epicormic branches spring and whence the sporophores emerge. It is therefore possible that unhealthy knotty looking poles are infected with *Trametes incerta*. Clear felling in any area infected with *Trametes incerta* would be a control measure.

The Conservator remarks that *Fomes* and *Trametes* are attackers of badly grown poor type sal on hill areas which are or have been desiccated by drought and fire, etc.

Experiments are to be initiated with control plots for the thorough study of these fungi and for devising means of overcoming the loss they occasion. In the belief that drought is probably the chief contributing factor regulating the attack it is proposed to lay out experimental plots, with contour trenches to see if irrigation will make the sal more resistant to attack. Infected poles will be cut back to see how long the new shoots will remain immune from attack when a plentiful supply is assured.

## CENTRAL PROVINCES AND BERRAR.

There is no special officer in the province for conducting forest botanical research nor do the necessary facilities exist. If a suitable officer could be spared, Balaghat Forest School would be the most suitable

place for starting a nucleus of a properly organised Herbarium and a Botanical Garden which will fulfil a long-felt demand of the department. For the present all identification and research work for the province is done by the Forest Research Institute, Dehra Dun.

The following observations are reported from divisions :—

*Amraoti*.—The prevalence of *Fomes pappianus* in the babul plantations seems to be due not so much to congestion as to soil factors. Very heavy and ill-drained soil is not very conducive to the growth of this species and consequently in such areas the plants are very sickly and easily succumb to fungal attacks whereas along well-drained streams they are comparatively free.

*Balaghat*.—There appears to be a special variety of *Bauhinia variegata* growing in this division. It has more or less uncleft and yellowish green glabrous leaves, instead of the usual cleft and greenish-blue glaucous leaves. Specimens will be sent to Dehra Dun to ascertain if this is only a variety of *Bauhinia variegata* or a new species of *Bauhinia*.

*Bilaspur*.—Some dying back of teak was noticed and specimens of dead twigs were sent to the Forest Research Institute to ascertain the cause of damage and suggest remedial measures. The dying back is observed to take place in late July and August and is followed by defoliation in September. A new flush of leaves appears soon after. Of the four possible causes of this dying back, viz., drought, frost, insect attack, and a secondary effect of defoliation; the last is thus automatically eliminated, because defoliation follows dying back. Frost also does not seem to be the cause as it was observed that the shoots that died back were the growth of the spring (March-April) following the frost (January). Similarly drought could not be a cause as July-August, when the damage occurs, are by far the wettest months. Thus it would appear that the agency responsible for the damage is some insect and further investigations to confirm this are being carried out.

Besides the four possible causes mentioned, the dying back might also be the result of physiological drought, i.e., a condition under which although there is plenty of moisture present in the soil, the roots are unable to absorb it, or excessive transpiration by the young and succulent tips of the trees, as a result of strong hot winds that blow during a prolonged break. The investigation might take these factors also into consideration.

*Mandla*.—The common violet was found growing near Chouradadar in March. *Curcuma aromatica* was seen flowering in the sal forests in April, which is considered early for this species.

*North Chanda*.—The climber *Aspidopterys cordata* was noticed to be very common in regeneration areas of the Moharli range.

## CHAPTER IV.

### FOREST ENTOMOLOGY.

#### BENGAL.

The insect girdling the collar of young *Cryptomeria* plants in Takdah Range, Darjeeling division, has been identified as the larva of *Phassus* sp. (*Hepialidae*).

The incidence of damage by the Champ Bug (*Urostylis punctigera*) was less during the year. Investigations on a defoliator of *Chukrassia tabularis*, and on the larvæ from girdled mahogany (*Swietenia macrophylla*) were continued during the year.

#### BIHAR.

Bagworms, *Clania* sp., attacked young foliage of *Callistemon*, *Casuarina*, *Dalbergia sissoo* and *latifolia* at the end of July 1937 in Hinoo nursery. A young shoot of *Eucalyptus citriodora* about 6" in length was completely destroyed in two days.

*Lagerstroemia flos-reginae* was attacked early in September 1937 by *Trabala vischnou* Lef. (*Lasiocampidæ*). As the area of attack is small the remedy consists in hand-picking or alternatively spraying with lead arsenate.

*White Ants*.—In the Experimental garden at Hinoo, it has often been noticed that exotics are more susceptible to white ant attack than indigenous species. Especially *Eucalyptus* and Cypresses have been badly attacked. Watering with 5 per cent. Phenyl with Karanj cake every three days, helps to reduce the attack.

*Forest Zoology*.—The tiger census in the Palamau forests, on April 30th, and May 1st, showed 19 tigers and 10 tigresses.

#### CENTRAL PROVINCES AND BERAR.

Increasing damage from browsing by game is reported everywhere and is attributed to an increase in the number of deer as a result of stricter game laws.

*Defoliators of teak*.—The following notes summarising the entomological research by the Forest Research Institute at Nilambur are given for general information :—

The parasites of teak defoliators released in Nilambur in 1937 are *Trichogramma* sp. (Burma), an egg-parasite of *Hapalia machaeralis* *T. minutum*, an egg-parasite of *Hyblaea puera* and *Cedria paradoxa*

larval parasite of *machaeralis*. These species have alternative hosts and it is expected that the colonisation will be successful.

The pre-existing parasitism of *machaeralis* and *puera* is also recorded.

The vegetation of teak plantations has been studied and lists of species which are (a) desirable, and (b) undesirable are given with reasons for the classification.

Of the species of plants which are considered desirable in teak plantations, because they are food-plants of defoliators that are alternative hosts of parasites of *machaeralis* and *puera*, the following occur in the Central Provinces.

\**Achyranthes aspera*, *Anthocephalus cadambe*, Bamboo, *Bauhinia racemosa*, *Boehmeria platyphylla*, *Borassus flabellifer*, *Casearia graveolens*, *C. tomentosa*, *Cassia fistula*, \**Cedrela toona*, *Celastrus paniculata*, *Dalbergia sissoo*, *Diospyros montana*, *D. tuperu*, *Ehretia laevis*, *Elaeodendron glaucum*, *Flemingia paniculata*, *Grewia* spp., \**Helicteres isora*, \**Holarhena antidysenterica*, *Jasminum pubescens*, *Lagerstroemia parviflora*, *Leea* spp., *Ougeinia dalbergioides*, *Pavetta indica*, *Solanum* sp., *Terminalia balerica*, \**Xylia xylocarpa*; and of the cultivated plants \*cotton, rice, sugarcane, tobacco, \*castor and \*mulberry.

Species marked thus (\*) support defoliators which are alternative hosts of parasites common to both *machaeralis* and *puera* and are thus potentially most useful.

Of the species of plants which are considered undesirable in teak plantations because they are alternative food-plants of *machaeralis* and *puera* or of other pests of teak, those found in the Central Provinces are :—

*Gmelina arborea*, *Lantana camara*, *Premna latifolia*, and *Vitex negundo*.

The efficiency of the control of *Hapalia machaeralis* by parasites may be considered satisfactory in Nilambur but the control of *Hyblaea puera* is still deficient.

## ORISSA.

Young *asan* (*Terminalia tomentosa*) plants, raised in *rab* sowings in Barapahar division, were attacked and killed by defoliators.

## CHAPTER V.

### UTILIZATION AND ECONOMIC RESEARCH.

#### ASSAM.

##### I.—GENERAL WORK OF ADMINISTRATION.

Mr. S. M. Deb held charge of the post of Utilisation Officer during the year under review.

##### II.—EXPERIMENTAL ACTIVITIES.

###### (1) *Wood Technology.*

The collection of wood specimens in connection with the work in progress on Assam timbers at the Forest Research Institute, Dehra Dun, was accelerated.

The Wood Technologist of the Forest Research Institute visited almost all the divisions of the Province immediately after the close of the year in connection with the same work, viz., the anatomical study of 183 species.

###### (2) *Timber Seasoning.*

As mentioned in the Annual Report for 1935-36, the Surma Valley Sawmills have finally agreed to install a seasoning kiln.

Dr. S. N. Kapur, Officer-in-charge of the Seasoning Section of the Forest Research Institute, Dehra Dun, paid a visit to the mills towards the close of the year under review, and gave necessary advice. A kiln with two chambers, each=11' 6" wide, 20' high and 28' long, with a capacity of 10 tons of  $\frac{1}{2}$ " planks, and with an operating room 27'×14' is under construction. The estimated cost is Rs. 40,000 (forty thousand rupees).

The erection is likely to be completed by the end of October 1938.

The Assam Railways and Trading Company's Sawmills at Margherita afford an example of how timber should be properly stacked for air-seasoning with the result that 50 per cent. higher prices are obtainable after one year's seasoning as against the green material usually supplied locally.

###### (3) *Timber Testing.*

Now that the planting of teak is being steadily increased, steps are being taken to find out the strength and working qualities of Assam teak as compared with that of Burma and elsewhere.

In view of the prospective use of treated sleepers, the following species have been selected for test at the earliest possible opportunity, as to their suitability for sleepers from the points of view of strength and capacity to absorb the requisite amount of preservative :—

*Gogra* (*Schima wallichii*).

*Sida* (*Lagerstrœmia parviflora*).

#### (4) Wood Preservation.

Some 15,000 (fifteen thousand) Metre Gauge hollow sleepers have been cut by the Assam Railways and Trading Company for use on their own line, after pressure treatment in their treating plant at Margherita with a mixture of 50 per cent. creosote and 50 per cent. crude oil.

#### (5) Wood Working.

(i) The following species were supplied for pencil making tests :—

*Bonsum* (*Phœbe goalparensis*).

*Titachapa* (*Michelia champaca*).

*Gunseroi* (*Cinnamomum glanduliferum*).

*Toon* (*Cedrela toona*).

*Gogra* (*Schima wallichii*).

*Sida* (*Lagerstrœmia parviflora*).

*Haldu* (*Adina cordifolia*).

*Uriam* (*Bischofia javanica*).

Of these, *uriam* (*Bischofia javanica*) was reported to be most suitable for the manufacture of pencils, and *haldu* (*Adina cordifolia*), *toon* (*Cedrela toona*), *bonsum* (*Phœbe goalparensis*) and *titachapa* (*Michelia champaca*) were found to turn out good pen-holders.

(ii) Three sets of tool-handles, as are ordinarily required by the Indian Railways, were converted from *ping* (*Cynometra polyandra*).

The East Indian Railway indicated a liking for the biggest type of handles made of this wood by ordering a supply of a small quantity of such handles.

(iii) A firm has found *bhelu* (*Tetrameles nudiflora*) a good substitute for the Andamans *dhup*, for the manufacture of portable cabinets covered with leather or leatherette.

(iv) In indigenous handlooms used in home industries in the Assam Valley, the use of *bonsum* (*Phœbe goalparensis*) for shuttles is increasing.

(v) *Bael* (*Aegle marmelos*) has been found to make excellent handles for chisels and small hand-planing tools.

(vi) The sapwood of *karol* (*Kayea floribunda*) has been found to make good handles for small tools.

(vii) *Sutrong* (*Lophopetalum fimbriatum*) makes excellent light ceiling boards capable of taking a high class polish.

(viii) Furniture makers are being advised to make drawers of ward-ropes and of cabinets, meant to protect respectively woollen clothing and valuable documents from vermin, with *gunseroi* (*Cinnamomum glanduliferum*).

(ix) *Kurta* (*Palaquium polyanthum*) makes a very good movable deck for country boats. The edges of planks do not deteriorate although badly exposed to the sun, moisture and constant rough use. This timber is therefore being recommended for bridge flooring after air-seasoning.

(x) *Rata* or *amari* (*Amoora wallichii*) is a favourite timber with the Surma Valley Sawmills for making furniture.

(xi) For the construction of articles such as camp furniture for which elasticity combined with strength and toughness is a desideratum for rough handling, *hatia* or *boga-poma* (*Chukrasia tabularis*) has been found a splendid timber.

(xii) *Jhalna* or *hollock* (*Terminalia myriocarpa*) has been found satisfactory for bottom boards, and is also likely to be used by one Railway for the construction of skeleton frames for carriages.

(xiii) The same Railway was also convinced of the utility of *bonsum* (*Phæbe goalparensis*) for panelling and ceiling in carriages, but the price and freight of this material from one end of the country to the other proved a bar to its economic use.

(xiv) Samples of *titachapa* (*Michelia champaca*) and *bonsum* (*Phæbe goalparensis*) have been sent to a firm in Great Britain, through the Timber Adviser to the High Commissioner for India, for testing their suitability for making engineers' patterns, such as models of aeroplane engines, motor engines, locomotive parts, etc.

#### (6) *Match woods.*

The Assam Match Company's Factory at Dhubri does not like to use any indigenous timber other than *simul* (*Bombax malabaricum*).

A Match Company of Calcutta has however agreed to use *bhelu* (*Tetrameles nudiflora*), *pituli* (*Trewia nudiflora*) and *kadam* (*Anthocephalus cadamba*), and has placed a trial order for the supply of these species.

(7) *Wood for packing cases.*

The Venesta Factory, Kamarhati, has after all taken to the use of *simul* (*Bombax malabaricum*) and *bhelu* (*Tetrameles nudiflora*) for chest hattens. Its dislike for these timbers, because of the influence of tradition, was noted in last year's Report.

The Calcutta dealers who so long preferred *simul* (*Bombax malabaricum*) and *bhelu* (*Tetrameles nudiflora*), have been convinced of the worth of several other species, and they are now taking also *kadam* (*Anthocephalus cadamba*), *pitali* (*Trewia nudiflora*), *dimaru* (*Ficus* spp.), *barpat* (*Ailanthus grandis*), *seleng* (*Sapium baccatum*), *satiana* (*Alstonia scholaris*), *bonjalakia* (*Cryptocarya amygdalina*) and *bonhonalu* (*Cryptocarya floribunda*).

(8) *Plywood and veneers.*

*Makai* (*Shorea assamica*) and almost all varieties of *sapas* (*Michelia* spp., *Talauma* spp. and *Manglietia* spp.) make excellent decorative plywood, ornamental veneers and laminated panels.

(9) *Paper pulp.*(a) *Bamboo.*

From a preliminary investigation, it appears that within the Province approximately 252,000 acres are covered by not less than 25 varieties of bamboo of which *muli* (*Melocanna bambusoides*), *kako* (*Dendrocalamus hamiltonii*), *khang* (*Dendrocalamus longispatus*) and *mir-tenga* (*Bambusa tulda*) predominate, and are therefore important from the pulp industry point of view.

About 56,000 tons of bamboos can be made available for annual supply, provided pulp making factories be established at suitable centres within or in the vicinity of the sources of supply.

(b) *Grass.*

*Imperata cylindrica* seems to cover about 205,000 acres of land all over the Province. The approximate annual supply of this species for pulp and paper manufacture may be estimated at 102,500 tons.

So long as pulp mills at suitable sites within the Province are not erected there is little chance for this material being utilised for the purpose, as transit charge to established mills is prohibitive.

(10) *Minor forest produce.*

*Pishachban* (*Eupatorium odoratum*).—As mentioned in last year's Report, 4 maunds of flowers of *Eupatorium odoratum* were supplied to

the Bio-Chemist, Forest Research Institute, Dehra Dun, for distillation of essential oil, and he reports as follows :—

“The flower heads of *Eupatorium odoratum* when received here were in a process of decomposition but were distilled immediately for their oil content. The yield of the oil is very very low and not enough for chemical examination.

In order to avoid the loss of oil during transit, due to decomposition or excessive drying, I would suggest your distilling flowers on the spot.”

*Bakhal bih (Milletia pachycarpa)*.—10 pounds air-dried thin roots were sent to the Bio-Chemist, Forest Research Institute, Dehra Dun, for rotenone test and the following is an extract from his report :—

“I have the honour to report that the samples of *Milletia pachycarpa* roots sent along with your letter No. B/859, dated the 19th November 1937, yielded 4.3 per cent. of total ether extract and 2.8 per cent. of rotenone. These results appear encouraging, especially when compared with the previous samples examined.”

*Guttapercha (Palauquium polyanthum)*.—The following report from the India Rubber, Gutta Percha and Telegraphs Works Co., Ltd., is in addition to what has been stated in the last year's Report :—

“The sample referred to has been examined in the Works. They state that when it is washed in hot water it becomes very adhesive and remains soft for a considerable while. The resin content appears to be very high and the proportion of gutta or rubber is not likely to exceed 10 per cent.

It does not resemble any of the guttas with which they are most familiar, and they could not use it to advantage.

They add, however, that users of gum chicle may find it interesting nevertheless, as it has similar properties, chiefly a low softening point.”

### III.—COMMERCIAL ACTIVITIES.

#### I. Timber Trade.

##### (a) Supply of woods to Railways.

###### (1) Sleepers—

Previous to the recent intervention of the Forest Department and Messrs. Himatsingka Timber Ltd., the Assam Bengal Railway used to purchase teak sleepers for their bridges and main crossings. These have now been replaced by *sal*.

*Nahor* (*Mesua ferrea*) and *hollong* (*Dipterocarpus macrocarpus*).—The Assam Railways and Trading Company, Ltd., have cut about 10,000 metre gauge sleepers of *nahor* for use in their own line and also some 15,000 *hollong* for utilisation after pressure treatment.

(2) *Timber other than sleepers*—

*Purchasers' Agency*.—About 600 tons of converted material mostly from the following species were supplied to the Assam Bengal Railway and the Tezpur Balipara Railway :—

*Bonsum* (*Phæbe goalparensis*).

*Titachapa* (*Michelia champaca*).

*Sal* (*Shorea robusta*).

*Amari* (*Amoora wallichii*).

*Haldu* (*Adina cordifolia*).

(b) *General*.

*Internal consumption*.—There has been a steady increase in the use of Assam timbers for plywood tea chests at the two local veneer mills.

*Export*.—The Surma Valley Sawmills did increase business in export trade. Improved export of Assam timber from all sources amounted to about 31,000 tons of wood consisting mainly of—

*Sal* (*Shorea robusta*).

*Sam* (*Artocarpus chaplasha*).

*Ajhar* (*Lagerstrœmia flosreginæ*).

*Amari* (*Amoora wallichii*).

*Bonsum* (*Phæbe goalparensis*).

*Gurjan* (*Dipterocarpus turbinatus*).

*Titachapa* (*Michelia champaca*).

*Gamar* (*Gmelina arborea*).

*Sutrong* (*Lophopetalum fimbriatum*).

*Khokan* (*Duabanga sonneratiodes*).

*Boga-poma* (*Chukrasia tabularis*).

*Poma* (*Cedrela toona*).

*Simul* (*Bombax malabaricum*).

*Bhelu* (*Tetrameles nudiflora*).

2. *Trade in minor forest produce*.

*Cane*.—The outlook of the trade in cane, which is virtually Assam's monopoly in the country, has been much brighter.

The prices for all varieties have gone up by 15 to 50 per cent.

*Bamboos*.—The demand from the paper pulp industry remains stagnant at only 2,000 tons a year, but from the neighbouring districts of Bengal for domestic use has considerably improved.

*Grass*.—There is a keen demand for thatching grass in the Surma Valley and Lower Assam.

Owing to the extensive use of corrugated iron sheets for roofs and to the Assam Oil Company using straw for packing their kerosine canisters in railway wagons, the consumption of grass seems to be steadily decreasing in Upper Assam.

*Lac*.—With a depressed market due to over-production in other lac growing Provinces and the tricks of the middlemen dealers, the local growers are receiving little encouragement. This situation is now under Government's consideration.

*Rubber (Ficus elastica)*.—Superior quality material from South India is selling in Calcutta at a price which is lower than the cost of collection of Assam rubber, hence the lessee has no other alternative than to suspend operations till matters improve.

*Honey*.—Paucity of normal crop in certain areas was responsible for high prices.

*Bees' wax*.—The market was very strong with prices moving in the favour of sellers.

*Herbal drugs*.—*Raktachita (Plumbago rosea)*.—Prices increased from Rs. 25 in last year to Rs. 40.

*Nux-vomica*.—A sale was made for the first time. 1 maund and 18 seers of *Nux-vomica* seeds were sold for Rs. 17-6-6 at Rs. 12 per maund.

*Chaubmugra (Hydnocarpus kurzii)* seed.—Production was below normal, immature seeds were collected by the lessees and there was lack of enthusiasm on their part to place them on the market in time for sale; hence trade was extremely dull.

*Pipul (Piper longum)*.—Although the market was active, two of our Mahals failed to attract tenderers. The reason is attributed to the scarcity of supply.

*Agar (Aquilaria agallocha)*.—The market was as strong as last year. A new mahal was created in North Kamrup.

*Boga-medeloa (Tephrosia candida)*.—One maund of *boga-medeloa* seeds was sold.

*Nahor seeds (Mesua ferrea)*.—A *nahor* seeds Mahal including Sib-sagar, Sadiya and Lakhimpur was sold for the first time.

Rhinoceros horns, skin and hoofs.—Two horns weighing 138 tolas were sold for Rs. 1,160 or Rs. 336-4 per lb. Five maunds of skin in a

damaged state due to decomposition were sold for Rs. 30 and 11 hoofs for Rs. 3.

*Ivory*.—15 maunds, 10 seers, 9 chattacks and 2 tolas ivory were sold in auction for Rs. 5,854 or Rs. 9-9-5 per seer against Rs. 10-10-6 in 1936-37 and Rs. 9-8-6 in 1935-36.

### 3. Railway freights.

*Timber*.—Reduction in Railway freight has been obtained for most of the forest produce. Previous rates were too high for trade and the new rates will benefit the Railways as well as the Department.

### 4. Publicity, propaganda and commercial advice.

(I) In the efforts to encourage an extensive use of Assam timbers, a great step forward in the matter of propaganda was made during the year under review as consuming and distributing centres were visited by the Utilisation Officer with samples of Assam timbers, many of which proved attractive to stockists.

(II) Next to *sal* (*Shorea robusta*), as regards quantity available, comes *hollong* (*Dipterocarpus macrocarpus*) but its internal consumption is only a negligible fraction of the annual possibility. The so-called *gurjan* in the Calcutta market from Burma, comprises several varieties of *Dipterocarpus* including *hollong*. The demand for such timbers in the Calcutta market is for mill sawn material, whereas unfortunately there is no suitable sawmill in our *hollong* areas to meet the demand. Formerly, transport charges were prohibitive. These have now been reduced, and attempts are being made to interest industrialists in the matter. The question of re-opening the sleeper treating plant at Naharkatiya was under discussion after the close of the year.

(III) A firm who had been using a huge quantity of boards for packing cases from Korea (Japan) was approached and presented with samples of *bhelu* (*Tetrameles nudiflora*) and *simul* (*Bombax malabaricum*) shooks. The Manager was strongly urged and agreed to buy almost all his requirements made of *bhelu* on the Utilisation Officer's recommendation from millers who obtain their supply of this species from the forests of Assam.

(IV) For the first time, *khair* (*Acacia catechu*) trees were sold for the manufacture of cutch and *katha* in the Haltugaon division during the year. A working scheme for *khair* areas has been prepared after enumerations.

(V) Some Railway engineers were personally approached, while others were written to, urging the suitability of Assam timber for their work.

(VI) Efforts to place firewood in local markets in large quantities at reasonable prices consisted in visiting production centres, giving necessary advice to suppliers and getting the Railway freight reduced by 20 per cent.

(VII) Assistance was given in the disposal of *sal* from Kamrup and Goalpara divisions particularly in settling transit charges with good results.

(VIII) A little over a crore of bamboos may safely be estimated as the normal annual output of our bamboo-bearing areas, of which about 50 lacs are annually extracted for domestic use.

The balance could therefore be used as pulpable material had it been possible to extract and deliver the same to pulp and paper mills at workable cost. Transit rates for long distances at present prevents this utilisation.

The solution is therefore to get some pulp making mills set up near the sources of raw material and with this object in view negotiations are now in progress with Calcutta.

(IX) An exhibition of curios manufactured from Assam ivory by those industrialists who attend our auction sales for purchase of elephant tusks was arranged at the office of the Forest Utilisation Officer. It was largely visited by gentlemen of the town who highly appreciated the exhibits and greatly admired and encouraged the manufacturers.

(X) Technical advice was given to sawmillers and other industrialists as well as to traders, big or small, and also to consumers.

(XI) Sellers were put in touch with purchasers.

#### 5. Results of the efforts to increase the sale of Assam timbers.

(I) During the year under report improvement was effected in prices of the following :—

##### (a) *Hardwoods*—

*Bonsum* (*Phæbe goalparensis*).

*Titachapa* (*Michelia champaca*).

*Amari* (*Amoora wallichii*).

*Ajhar* (*Lagerstræmia flos-reginæ*).

*Gamar* (*Gmelina arborea*).

*Poma* (*Cedrela toona*).

*Hollock* (*Terminalia myriocarpa*).

*Sal* (*Shorea robusta*).

(b) *Softwoods*.—After a long struggle with the Calcutta millers prices of woods for packing cases have been raised.

6. *Miscellaneous.*

(i) *Departmental sleeper supply.*—The aim and object of the departmental contract for sleepers was fully explained in last year's report. More lamentable was this year's supply from the indigenous contractors. Only 594 out of 50,000 sleepers were supplied by them and the balance was made up from other sources.

(ii) *Railway conferences.*—No less than 5 conferences with Railways were arranged for and attended to discuss the possibility of introducing such rates of freight as would be mutually workable in the joint interest of both traders and transporting agencies.

(iii) *Collection of specimens.*—A large number of specimens were collected for the proposed forest products museum.

(iv) *Supply of samples.*—Samples of various forest products intended for commercial and industrial trial for exhibits in museums and also for educational purposes were liberally distributed.

(v) *Publication.*—The writing of a hand book of forest products of Assam has been taken up.

(vi) *Enquiries.*—More than three hundred miscellaneous enquiries were answered on timber, bamboo, cane, lac, agar wood, resin, honey, bees' wax, fish poisons and drugs.

(vii) *Identification.*—14 pieces of timber were identified, 12 for the Assam Bengal Railway and 2 for Messrs. Himatsinghka Timber, Ltd.

They included *bonsum* (*Phæbe goalparensis*), *khokan* (*Duabanga sonneratiodes*) and *phulchapa* (*Manglietia insignis*). Sample sent as *bonsum* (*Phæbe goalparensis*) was identified as *khokan* (*Duabanga sonneratiodes*).

At the request of the Deputy Controller of Stores, East Indian Railway, a few varieties of cane were identified before him in his office. Samples tendered by his contractor as Malacca cane were found to include about 10 per cent. of Malacca cane, 20 per cent. of *sundi bet* and 70 per cent. of *tita-bet*, the latter two being natives of Assam forests. The strength, durability and utility of *tita-bet* for the purpose of baskets meant for such rough wear as carrying of coal, earth and ballast, were shown to him and he was told how to identify *tita-bet* and also to test the mechanical strength of cane baskets which were appreciated by him. He has agreed to insist upon the supply of Assam *tita-bet* in his future call for tenders for cane baskets.

(viii) *Liaison.*—The usual liaison was maintained with the Provincial Silviculturist and Botanical Officer; Specialists at the Forest Research Institute, Dehra Dun, Director of Commercial Intelligence

and Statistics, Calcutta ; Director, School of Tropical Medicine, Calcutta ; the Officer-in-charge, Commercial Museum and Publicity Department, Corporation of Calcutta. Acknowledgments are due for help from all these sources and also to Mr. A. K. Bose, Superintendent, Rates, Development and Publicity, Eastern Bengal Railway, and Messrs. R. G. Manson, Chief Operating Superintendent and R. S. Vipani, Chief Commercial Manager, Assam Bengal Railway, for their sympathetic co-operation in the matter of removing high freight rates for the development of trade in forest products.

(ix) *Aims and achievements*.—As some sections of the public appear to be still ignorant of the aims and objects of the Utilisation Branch and also of the benefits of its activities the remarks made last year in this connection are repeated below :—

The primary object is to develop the utilisation of all the natural resources of our forests and to place an increasing supply of marketable products within the reach of the public. This aim is to be so attained as in the process to bring in to Government the full value of the same.

The beneficial effects should be found in the improvement in prices of raw materials and the consequent increase of the net revenue.

## BENGAL.

### I.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Utilisation Officer, Bengal, was held by Mr. C. T. Trigg, Deputy Conservator of Forests, from 1st April 1937 to 24th November 1937, and Mr. S. Chaudhuri, Deputy Conservator of Forests, from 25th November 1937 to 31st March 1938.

### II.—COMMERCIAL ACTIVITIES.

#### Sales.

(a) *B. G. sleepers*.—Orders for the supply of 5,000 B. G. sleepers were received during the year under report at rates of Rs. 4-11-0 and Rs. 4-13-0 each f.o.r. loading station.

(b) *M. G. sleepers*.—An order for the supply of 10,000 sleepers was received at Rs. 1-15-3 each f.o.r. despatching stations.

(c) *Light N. G. sleepers*.—An order for the supply of 1,000 Light Narrow Gauge sleepers was received at Rs. 0-13-6 each f.o.r. despatching stations.

(d) *Special sleepers*.—An order for the supply of special sleepers to the value of Rs. 19,378-4-0 was received at rates varying between Rs. 1-10-0 to Rs. 10-7-6 each sleeper f.o.r. loading stations,

(e) *Sal logs*.—Round sal (*Shorea robusta*) logs to the value of Rs. 33,965-0-0 were supplied to the various railways and Government firms.

(f) *Sawn sal timber*.—Sal (*Shorea robusta*) planks and scantlings to the value of Rs. 1,597-8-0 were sold to various firms during the year under report.

(g) *Sal ballahas*.—An order for the supply of 4 sal (*Shorea robusta*) ballahas to the value of Rs. 148-8-0 was received during the year under report.

(h) *Birch*.—Orders for birch (*Betula alnoides*) squares and planks to the value of Rs. 1,482-11-0 were received at the rates of Rs. 1-2-0 and Rs. 0-15-0 per c.ft. f.o.r. loading stations.

(i) *Toon*.—Orders for the supply of sawn toon (*Cedrela toona*) timber to the value of Rs. 3,425-2-6 were received from various firms and Government Departments and were supplied from Kalimpong, Kurseong and Buxa divisions.

(j) *Sissoo*.—Orders for the supply of sissoo (*Dalbergia sissoo*) logs to the value of Rs. 6,400-0-0 were received and were supplied to the firms and railways concerned within the year under report.

(k) *Gurjan*.—Orders for the supply of gurjan (*Dipterocarpus turbinatus*) logs were duly received from the railways like the previous year during the year under report, and the total value of the supply from the Chittagong Hill Tracts division amounted to Rs. 10,195 only.

(l) *Gamari*.—Orders for the supply of gamari (*Gmelina arborea*) planks to the value of Rs. 2,168-12-0 were received during the year under report.

(m) *Jarul*.—Jarul (*Lagerstræmia flos-reginæ*) scantlings to the value of Rs. 36-0-0 were sold from the Chittagong Hill Tracts division during the year under report.

(n) *Match-wood logs*.—Orders for the supply of simul (*Bombax malabaricum*), pitali (*Trewia nudiflora*), kadam (*Anthocephalus cadamba*), logs suitable for match manufacture were received from various match-manufacturing firms in Calcutta.

(o) *Miscellaneous timbers*.—Orders for the supply of mixed timbers such as pakkasaj (*Terminalia tomentosa*), chickrassy (*Chusquea tabularis*), gumar (*Gmelina arborea*), lampatia (*Duabanga sonneratioides*), lali (*Amoora wallichii*), toon (*Cedrela toona*), chapalish (*Artocarpus chaplasha*), champ (*Michelia champaca*), willow (*Salix tetrasperma*), siris (*Albizia lebbek*), karam (*Adina cordifolia*), etc., to the value of Rs. 1,541-2-9, were supplied from Kurseong and Buxa divisions during the year under report.

(p) *Civit*.—An order for the supply of 20 tons of civit (*Swintonia floribunda*) at Rs. 25 per ton f.o.r. Chittagong, was received from Messrs. Mansfield & Sons, Calcutta.

### III.—EXPERIMENTS AND RESEARCH.

#### (1) Wood Technology.

A key for the identification of 34 Bengal timbers is being prepared at the Forest Research Institute, Dehra Dun. All species with the exception of one or two have been sent to Dehra Dun, and the rest will be despatched soon from divisions.

#### (2) Timber seasoning.

*Cedrela toona*.—Reports on 10 tons of forest grown toon (*Cedrela toona*) sent to the Utilisation Officer, Forest Research Institute, Dehra Dun, for kiln-seasoning experiment under Project VII, for comparison with road side toon, have not yet been received.

#### (3) Timber Testing.

(i) Logs of the following species were sent to Dehra Dun during 1934-35 for test under Project VIII (Veneer and Plywood).

<i>Terminalia tomentosa</i> . . . . .	Kurseong.
<i>Anthocephalus cadamba</i> . . . . .	Kurseong.
<i>Artocarpus chaplasha</i> . . . . .	} Chittagong Hill Tracts.
<i>Gmelina arborea</i> . . . . .	
<i>Lagerstræmia flos-reginæ</i> . . . . .	
<i>Michelia champaca</i> . . . . .	
<i>Dipterocarpus turbinatus</i> . . . . .	

(ii) *Castanopsis hystrix*.—A sample of this timber was sent from Darjeeling division in 1934-35 for test under Project VIII (Veneer and Ply-wood) and the following report has been received:—

“Peeled-green. Slight evidence of stain near sap. Free from insect attack and knots. Too fast grown. Peels coarse. Woolly in spots and fibres pick up badly. Numerous cracks causing short lengths. Useless for ply-wood.”

(iii) To compare with *Grewia tilæfolia*, 5 logs of *Grewia vestita* were sent to the Forest Research Institute for testing under Project I from the Kurseong Forest division during 1934-35.

(iv) *Gmelina arborea*, 4.

*Artocarpus chaplasha*, 4.

*Dipterocarpus* spp., 4.

*Michelia champaca*, 4.

Sample logs of the above species were sent to the Dehra Dun Forest Research Institute from Chittagong Hill Tracts division during 1934-35 to test their quality with a view to the possibility of extending their use outside Bengal.

(ix) One log of each of the following species was sent to Messrs. C. Lazarus and Company, Calcutta, for test in the manufacture of furniture :—

From Kurseong division—

Chickrassy (*Chuckrasia tabularis*).

Pakasaj (*Terminalia tomentosa*).

Chapalish (*Artocarpus chaplasha*).

From Sundarbans division—*Pussur* (*Carapa moluccensis*).

No report has yet been received.

(x) *Sonneratia apetala*.—Two *keora* (*Sonneratia apetala*) logs were supplied to Messrs. Mansfield & Sons, Calcutta, for test in heavy packing and turned out to be quite suitable for the purpose.

(xi) *Gmelina arborea*.—One sample piece of gamari (*Gmelina arborea*) was sent to Messrs. Chittaranjan Crochet Cotton Manufacturing Company, Calcutta, for testing in making reels, etc., from Kurseong division, but no report has yet been received.

(xii) *Terminalia tomentosa*.—One sample piece of laurel (*Terminalia tomentosa*) was sent to Messrs. Coondoo Paul & Coy., Calcutta, for test in the manufacture of wooden handles from Kurseong division, but no report has been received.

(xiii) *Michelia champaca*.—(a) Three specimens of champ (*Michelia champaca*) were sent to the Timber Adviser to the High Commissioner for India, London, for testing its suitability for making engineers patterns.

(b) *Alnus nepalensis*.—Arrangements are also being made to send 3 more specimens of utis (*Alnus nepalensis*) to the Timber Adviser to the High Commissioner for India, London, from India, for the same purpose.

(xiv) Logs of the following species were sent to Messrs. G. C. Law & Company, Calcutta, for testing their suitability in the manufacture of pencil and penholders :—

(1) Hill toon ( <i>Cedrela microcarpa</i> )	. . . . .	From Kalimpong division.
(2) Lali ( <i>Amoora wallichii</i> )	. . . . .	From Kurseong division
(3) Kainjal ( <i>Bischofia javanica</i> )	. . . . .	Do.
(4) Gamari ( <i>Gmelina arborea</i> )	. . . . .	Do.
(5) Toon ( <i>Cedrela toona</i> )	. . . . .	Do.
(6) Mahogany ( <i>Swietenia macrophylla</i> )	. . . . .	From Chittagong Hill Tracts.

(7) Malatta ( <i>Macaranga denticulata</i> )	. . . . .	From Buxa division.
(8) Do. ( <i>Macaranga indica</i> )	. . . . .	Do.
(9) Hatipaili ( <i>Pterospermum acrifolium</i> )	. . . . .	Do.
(10) Kawla ( <i>Machilus gamblei</i> )	. . . . .	Do.
(11) Lasune ( <i>Amoora rohituka</i> )	. . . . .	Do.
(12) Champ ( <i>Michelia champaca</i> )	. . . . .	Do.
(13) Ramgua ( <i>Horsfieldia kingii</i> )	. . . . .	Do.
(14) Chewripatey ( <i>Meliosma simplicifolia</i> )	. . . . .	Do.
(15) Mauwa ( <i>Engelhardtia spicata</i> )	. . . . .	Do.

Reports submitted by Messrs. G. C. Law & Co., Calcutta, on the above logs are given below :—

- (1) Kainjal (*Bischofia javanica*) :—Suitable for manufacture of pencils.
- (2) Lali (*Amoora walichii*) :—Suitable for manufacture of penholders and pencils.
- (3) Gamari (*Gmelina arborea*) :—Unsuitable for the manufacture of pencils and penholders.
- (4) Hill toon (*Cedrela microcarpa*) :—Suitable for pencil making.
- (5) Mahogany (*Swietenia macrophylla*) :—Due to high price of the timber it cannot be used for the manufacture of pencils and penholders.
- (6) Toon (*Cedrela toone*) :—Suitable for pencil making.
- (7) Malatta (*Macaranga denticulata*)
- (8) Hatipaili (*Pterospermum acrifolium*)
- (9) Kawla (*Machilus gamblei*)
- (10) Mawa (*Engelhardtia spicata*)
- (11) Champ (*Michelia champaca*)
- (12) Ramgua (*Horsfieldia kingii*)
- (13) Chewripatey (*Meliosma simplicifolia*)
- (14) Lasune (*Amoora rohituka*)

} Not suitable for  
pencil or penholder  
manufacture.

} Good for both pen-  
cil and penholder  
making.

(xv) Hand samples of the following species were sent to the Manager, Venesta Box Factory, Kamarhati, from Kurseong division, for testing the manufacture of making corner pieces of venesta tea boxes :—

1. Kadam (*Anthocephalus cadamba*).
2. Mainakat (*Tetrameles nudiflora*).
3. Pituli (*Trewia nudiflora*).
4. Chickrassy (*Chuckrasia tabularis*).
5. Chatiwan (*Alstonia scholaris*).

6. Kainjal (*Bischofia javanica*).
7. Plains kawla (*Machilus gambleri*).
8. Raktan (*Lophopetalum fimbriatum*).
9. Latikaram (*Hymenodictyon excelsum*).

No report has yet been received.

(xvi) *Shorea robusta*.—A comparative result of test on sal (*Shorea robusta*) from Sukna range of Kurseong division with sal from Kalimpong and Jalpaiguri divisions (one consignment) received from the Forest Research Institute, Dehra Dun, are given below :—

“Although in the green condition, Kurseong sal appears to be slightly superior to the other consignment, it has gone down in air-dry values showing poor improvement of strength due to seasoning. It has suffered considerably in sheer and tension in the radial directions. The ratio of tangential and radial shrinkage is also greater. All this points to a slightly greater tendency to split and check.

It saws and machines reasonably well and is suitable for the usual run of purposes for which sal is put although it may check slightly more than other sal.”

(4) *Wood Preservation* :—Nil.

(5) *Minor Forest Produce*.

*Gurjan oil*.—(a) The tapping of gurjan oil departmentally has been abandoned.

(b) The results of the experiment on one pound of gurjan oil sent to Messrs. Johnson & Nicholson (India), Ltd., Calcutta, from Chittagong division during 1935-36 is not yet known.

(c) A sample tin of gurjan oil was also supplied to the Director of Industries, Bengal, from Chittagong division in 1933-34, for test as to its suitability for paint manufacture but no report has yet been received.

(d) Some seeds and roots of *Sapium indicum* were sent to the Biochemist, Forest Research Institute, Dehra Dun, for experiment as to whether it has the qualities of a fish poison.

(6) *Paper pulp*.

One ton of unharked *gengwa* (*Excoecaria agallocha*) was sent to the Utilisation Officer, Forest Research Institute, Dehra Dun, for experimental work on the preparation of mechanical pulp, but no report has yet been received.

*Bamboos*.—A specimen of *Dendrocalamus hamiltoni* was sent from Kalimpong division to the Officer-in-charge, Commercial Museum of

the Corporation of Calcutta, for exhibition according to his request, and it is reported to have been highly admired.

*Charcoal briquettes.*—*Cryptomeria japonica* is unsatisfactory both for fuel and charcoal, owing to its habit of sparking. 9 maunds 35 seers of *Cryptomeria* charcoal were prepared and sent to Dehra Dun from Darjeeling division for test in making charcoal briquettes. If *Cryptomeria* charcoal can be used in the form of briquettes, which do not have a tendency to spark, it will materially increase the saleable value of the *Cryptomeria* fuel.

(7) *Tans* :—Nil.

(8) *Wood working*.

(i) A mature *timur* (*Zanthoxylum budrunga*) tree was felled and sawn up in the Buxa division for local experiment, as this timber was much used in the Dacca District for furniture making. The timber has not behaved well there, cracking and splitting badly even in the log when it was sawn.

(ii) No report on the specimens of gurjan (*Dipterocarpus turbinatus*) sent to the Ceylon Government Railways, Colombo, has yet been received.

(iii) Report on the specimens of sal (*Shorea robusta*) sleepers sent to Ceylon and the Sudan has not yet been received.

(iv) Specimens of the following were sent to the Utilisation Officer, Forest Research Institute, Dehra Dun, from Jalpaiguri division :—

<i>Dalbergia sissoo</i>	.	.	herbarium specimens.
<i>Trewia nudiflora</i>	.	.	fruit, leaf, and wood specimens.

(v) Some *Salix tetrasperma* was supplied to the Superintendent, Cordite Factory, Aruvankadu, for experiments.

(vi). Tali (*Dichopsis polyantha*) is abundant in Chittagong Hill Tracts division. It is required to test its strength to see if it could be substituted for imported oregon pine and if a market could be created for it. The Utilisation Officer, Forest Research Institute, Dehra Dun, says that the species has been added to their test programme and has asked for 5 logs to be sent for the purpose. Arrangements have been made to send the logs to Dehra Dun for testing.

(vii) The following samples of timbers were supplied from Kurseong division :—

(a) One piece of gamari (*Gmelina arborea*) scantling to Messrs. Chittaranjan Crochet Cotton Manufacturing Company, Calcutta.

(b) Two samples of chickrassy (*Chuckrasia tabularis*) planks were sent to Mr. B. N. Ghosh, Government and Railway Contractor, Delhi.

(viii) Samples of laurel (*Terminalia tomentosa*) from Kalimpong division have been sent to railways and others, and it is hoped to be able to introduce it in the market.

#### (10) *Miscellaneous.*

(i) *Medicinal plants.*—Enquiries were made by Messrs. Birla Bros., Calcutta, regarding medicinal plants available in the Sinchal range (Darjeeling division) and they were informed that *Dyckroa febrifuga* plants were abundant, but no reply was received from the Company during the year under report.

(ii) *Introduction of silage feeding of cattle in the Hills.*—4 experimental silo-pits were constructed at Dilaram (Kurseong division), Sukiapokhri, Jorebungalow and Takdah (Darjeeling division) respectively. They were filled with fodder collected from our plantations. Grasses were collected in preference to other species with the object of making good silage.

The objects of this experiment are :—

- (a) To introduce the silage system to the local population and to encourage them to use this type of fodder when fodder is short during the dry season.
- (b) If this system is introduced successfully it should reduce lopping and cutting of prohibited species in the forest during the dry season by fodder cutters.
- (c) Another object in view is that if plantations are cut for fodder for the preparation of silage under departmental control, it will lessen the cutting of coppice and natural seedling recruitment in the plantations.

(iii) The usual liaison was maintained with the Divisional Forest Officers, Timber Advisory Officer to the Railway Board, Timber Adviser to the High Commissioner for India, London, and the Forest Research Institute, Dehra Dun.

#### *General.*

The Forest Utilisation Office is still of fairly recent origin in Calcutta having been established hardly 2 years back, but the increased calls and invitations received for technical advice and information more than justify the decision of transferring the Headquarters from Darjeeling to Calcutta.

A proposal for a joint bureau for controlling the sales and publicity of forest produce of several neighbouring provinces in Calcutta is under the consideration of Government.

Although the maximum possible timber out-turn of the province is not sold, the quantity of building material and soft wood that this province imports from foreign countries, including Burmah, is amazing.

Whether this is due to lack of facilities of extraction or transport or the unsuitability of indigenous wood, will have to be investigated. It is necessary to have a detailed survey made of the requirements of forest produce of the population of every district of Bengal, the source of their present supply, and the possibility of economic utilisation of the Province's produce to satisfy these requirements.

Calcutta is by far the most important timber market within the whole of India. As much as 8,000 cubic tons of timber were imported into Calcutta during the month of March 1938 by sea.

To achieve the desired result the establishment of up-to-date saw-mills for better conversion, and the introduction of seasoning kilns and impregnating plant for the improvement of our indigenous materials may be necessary. Legislation and the co-operation of the Railways and the Steamer Companies to transport our materials at competitive rates of freights, may also be necessary.

Negotiations on these lines with the authorities concerned have already been undertaken.

## BIHAR.

### I.—GENERAL WORK OF ADMINISTRATION.

The Forest Research Officer, and the Working Plans Officer held charge of the Utilization office during the year under review. The assistance of the Utilization Ranger was only available for a short time from July to December 1937, after which he was attached to the Working Plans office.

### II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

*Grading rules for timbers.*—As reported last year, grading rules were printed, and complimentary copies were distributed to all engineering firms, principal contractors and consumers of the Province, and to Utilisation Officers of other provinces. Extra copies on payment were asked for and supplied to several Divisional Forest Officers in the Central Provinces, Bombay and Madras.

*Railway freight.*—As a result of representation to the Superintendent, Rates and Development, as outlined in last year's report, success was achieved in getting the freight rates for charcoal from exporting stations of Singhbhum District reduced, with effect from 1st January 1938.

*Publicity and propaganda.*—Several enquiries were made for Indian Forest Record, Vol. XVIII, Part X, "Physical and Mechanical Properties of Woods grown in India", and these were forwarded to the Forest Research Institute. A few extract reprints were issued free to Public Works Department Chief and Superintending Engineers. As mentioned last year, the four utilisation posters from the Forest Research Institute were converted to linen hacked pictures and distributed to all Engineers, District Magistrates, Engineering Colleges and firms, Divisional Forest Officers and Range Officers.

Besides this, pictorial postcards entitled "What does the future require of you" and "Save your forests and prevent desolation", showing pictures of first quality sal alongside eroded country, were also widely distributed.

*Exhibitions.*—Due to lack of funds and insufficiency of staff, the Department could not participate in the provincial exhibition at Patna.

*Khunti exhibition in Ranchi District.*—We were invited to participate in the second annual exhibition of agricultural products at Khunti, held in January 1938. Wood samples and minor forest products and several forest pictures and posters were sent to the exhibition held there under the supervision of the officiating silvicultural Forester. The exhibits were well displayed in the lecture hall of the Middle English School alongside the exhibition ground. Mr. J. N. Sinha, E.A.C.F., also delivered two lectures in English and on the third evening officiating Forester M. Bodra, delivered one in Uraon. The lectures were much appreciated. We have now a good collection of two hundred and eighteen slides as subject material for lectures.

A certificate of merit was awarded by the Managing Committee of the exhibition.

*Ranchi exhibition.*—On return from Khunti, all the exhibits, plus others from the head office, were exhibited in Ranchi Gait Park in a swiss cottage tent. Several boxes of seedling plants were also exhibited and some were sold.

*Santal Parganas exhibition.*—The Divisional Forest Officer, Santal Parganas, again requested for exhibits for the Hizla mela, but owing to the short notice given none could be sent.

*All-India fibre exhibition at Calcutta.*—Exhibits of rope made of sabai grass (*Pollinidium angustifolium*) and *Bauhinia vahlii* creeper were sent to this exhibition held on the 15th March 1938.

Picture frames with celluloid fronts for grouping full size photos on Wood Preservation, Reclamation, Grazing, Erosion and Denudation, Transport, and Seasoning of Timbers have been made. More groups are to be framed this year. These pictures will be invaluable for educational purposes at exhibitions.

Experience has shown, and is showing ever more clearly, that propaganda and education of the general public, and of the engineers of the Province, in forest matters, is one of the main duties of the Utilisation office. During Mr. Kamesam's hurried visit in July 1936, one engineer confessed that "We engineers know little about the value and strength of timbers and have few books to guide us".

Since then much has been done to improve the position by getting the Forest Research Institute to send appropriate literature sometimes free, sometimes on purchase, while the Institute's posters are now in the hands of all engineers. But in order to keep engineers abreast of current thought and practice in timber engineering they should receive regular supplies of current literature. One of the most effective ways of doing this is to circulate to them monthly timber periodicals.

From the monthly bibliography of the Imperial Forest Institute, Oxford, two periodicals have recently been selected, one American, the other British, which practically cover the whole ground of timber engineering activity. Copies of these periodicals have already been circulated to the Chief and Superintending Engineers and have been very favourably received. Cyclostyled copies of summaries of the more important issues have also been sent to all Executive and District Engineers, and these have evoked immediate requests from several for the favour of receiving the magazine itself for perusal. The Superintending Engineer of Bhagalpur especially wished to circulate copies to all his Executive and District Engineers. It is impossible for one single copy of each magazine to do service for all engineers. Besides this, Divisional Forest Officers ought to keep abreast of the times.

To organise this education in timber matters effectively, six copies of each magazine monthly, are required. The cost would be about Rs. 170-0-0 annually. Two other books obtained with the help of the bibliography, namely Timber Connectors and a wood preserving pamphlet showing how concrete roadways are attached to the timber substructure, were also circulated to engineers, but each engineer should have his own copies.

The annual limit of Rs. 300-0-0 for periodicals in the whole circle was never intended to meet a situation such as this. At present, in order that engineers shall receive even the one circulated copy, money badly needed for other forest periodicals has to be curtailed. Government have been approached to increase the grant to Rs. 600-0-0.

Much work on propaganda was done during the year, and valuable information from pamphlets and periodicals was brought home to engineers through cyclostyled copies.

The proposal for erecting an Ascu treated bridge over the Suharna-  
rekha river on the Piska-Daladali road, by the District Engineer of

Ranchi, may perhaps be attributed to the result of this propaganda. The total cost f.o.r. Ranchi, for treated sawn timber was estimated to be Rs. 2-11-9 per c. ft.

*Summary of Results.*—In pursuance of the Utilization policy, the Forest Research Officer surveyed inland and foreign markets for established contact between consumers and suppliers of forest produce.

Two trial wagon loads of gumhar (*Gmelina arborea*) and *chilbil* (*Holoptelea integrifolia*) in 8", 10", and 12" squares, have been arranged with a contractor for testing as a moulding wood. The consignment is expected to be despatched by June 1938.

The visit of Mr. Trotter, Forest Utilisation Officer of the Research Institute, at the end of January 1938, has stimulated interest in Bihar timbers. The suggestion that pre-fabricated Ascu treated sal might be used for the erection of coolie huts is being followed up.

*Principal, Indian School of Mines, Dhanbad.*—This Institute requires woods for furniture making. Samples of *Pterocarpus marsupium*, *Albizia procera*, *Terminalia tomentosa*, *Gmelina arborea*, *Hymenodictyon excelsum*, and *Holoptelea integrifolia* were sent for his approval. He subsequently placed orders for well-seasoned pieces.

Samples of sixteen commercial timbers were made and supplied to the Orissa States Forest School with a short description of their uses, weight in lbs. per c. ft. at 12 per cent. moisture content, and approximate annual yield.

*General Engineering Company, Gaya.*—As a result of supplying posters to this firm, we were requested to arrange for a supply of treated wood for constructional purposes.

*Gun stocks.*—Samples of *safed siris* (*Albizia procera*) were supplied from Palamau to Messrs. Mullick & Co., Patna, for testing as gun stocks. They reported that the sample was cracked, otherwise it was quite suitable. The cracking was attributed to that particular specimen being unseasoned when supplied. 36 *Albizia procera* planks in sizes varying from 6' × 18" × 6" to 8' × 6" × 1½" are now being seasoned in the Chipadohar seasoning shed since March last. Samples of 6" thick planks will be sent for trial after 18 months' seasoning, and the 1½" thick plank after the rains.

*Tool handles.*—Babu Tarapado Bose, well versed in mechanical engineering, has been given a lease in Singhbhum for *dhaura* (*Anogeissus latifolia*) with option of also taking *karam* (*Adina cordifolia*), *arjun* (*Terminalia arjuna*), *amsabita* (*Mitragyna parvifolia*), *safed siris* (*Albizia procera*), *kendu* (*Diospyros melanoxylon*), *sidha* (*Lagerstræmia*

*parviflora*) on a royalty basis. 26 *dhaura* (*Anogeissus latifolia*) and 24 trees of other species have been felled by him and he is now seasoning the converted material at Chakradharpur. His machinery has arrived and he is busy erecting it. He hopes to extract to Chakradharpur by petrol lorry as this is considerably cheaper than railway freight *plus* double handling charges.

As mentioned last year, we are still awaiting samples of tool handles from the Forest Research Institute made of *kendu* (*Diospyros melanoxylon*), *sidha* (*Lagerstræmia parviflora*), *dhaura* (*Anogeissus latifolia*), *kusum* (*Schleichera trijuga*), *asan* (*Terminalia tomentosa*), and *dhaman* (*Grewia tiliafolia*). These are to be sent as soon as the wood is seasoned.

*Match woods*.—Several enquiries for woods suitable for match manufacture were received during the year. *Salai* (*Boswellia serrata*), *char* (*Buchanania latifolia*), *simul* (*Bombax malabaricum*) and *amra* (*Spondias mangifera*) are the commonest species in this Province.

A definite order for 1 ton *Boswellia serrata* a day is expected from Messrs. B. C. Roy & Co., Ranchi, but our supplies of match wood species are too limited, and it is doubtful if the full requirements can be met. However, the question of enumeration of *salai* (*Boswellia serrata*) in Palamau division is under consideration.

*Boxwood species*.—Our supplies of boxwoods are far too small to meet the demands of enquirers.

*Foreign market*.—An enquiry from the High Commissioner for India has been received for sending samples in 12" × 6" × 3" sizes of species suitable to replace *Alstonia* for pattern making. Samples of nine different species were sent, three of them being better than *Alstonia* itself. We are hopeful of receiving an order.

*Electrical poles*.—240 light transmission poles, of 300 lb. carrying capacity, were supplied to the Darbhanga-Laheriasarai scheme (65), the Ranchi extension scheme (25), and to the Berhampur Electrical Supply Company (150), for which a royalty of Rs. 6-0-0 per pole, less 5 per cent. commission to this office, was received by Divisional Forest Officers.

*Bihar grid scheme*.—Acting on press reports, enquiries to the Electrical Inspector elicited the information that at least 10,000 poles would be required. Government were notified that if orders were to be placed with us, at least 18 months notice should be given for collecting, partly seasoning, impregnating and again seasoning the poles. The Special Officer now in charge of the scheme was advised that a special rate of 0-12-9 per c. ft. for impregnation would be quoted to Government by Callender's for any poles required for that scheme, which means that the 300 lb. class pole of 30' length would cost about Rs. 13-0-0 and the cost of 500 lb. pole of 36' would be Rs. 16-0-0 or Rs. 17-0-0.

(1) *Wood technology*.—Nil.

(2) *Timber seasoning*.—A second seasoning shed has been constructed at Goilkera, with 8 stack capacity, for Rs. 840-0-0. The first seasoning shed at Chippadohar is already in use for supplying Messrs. Tatas with moulding woods of *chilbil* (*Holoptelea integrifolia*) and *gumhar* (*Gmelina arborea*).

(3) *Timber testing*.—Nil.

(4) *Wood Preservation*.—The Ascu plant has been finally installed at Goilkera as the most convenient centre for the Singbhum forests. More than 600 poles have been impregnated in this plant and 240 have been sold.

(5) *Minor Forest Produce—medicinal plants*.—Several enquiries for a list of medicinal herbs and plants were received during the year. A booklet giving botanical and vernacular names of all medicinal plants and herbs found in the forests of Bihar and Orissa is under compilation. This will be printed and circulated to all Pharmaceutical Institutions.

(8) *Grass*.—The Talchar *sabai* grass factory has sent samples of mats weaved with *sabai* grass (*Pollinidium angustifolium*) to a firm in England, from samples supplied by the Forest Department. These have been appreciated. The firm's requirements are for mats in 40 yards lengths, in widths of 12", 24" or 36".

(9) *Hay*.—Results of analysis of grasses, sent from Palamau division to the Agricultural Chemist, Sabour, are given below.

Serial No.	Lab. No.	Bihar office No.	Name of the grass.	Moisture.	CHEMICAL COMPOSITION PERCENT ON OVEN DRY MATTER.						DIGESTIBLE CONSTITUENTS.				Starch equivalent per 100 lbs. of matter.
					Nitrogen.	Ash.	Ether extract.	Crude protein.	Crude fibre.	N. free extr. including carbo-hydrate.	E. Extr.	Crude protein.	Crude fibre.	N. free extr. including carbo-hydrate.	
1	F <sub>11</sub>	1	<i>Chrysopogon monticola</i> Trin.	8.66	0.72	9.6	1.86	4.48	26.48	57.6	0.98	2.24	14.56	38.98	87.10
2	F <sub>11</sub>	3	<i>Rotibalia exaltata</i> . .	9.22	0.84	10.8	0.80	5.25	31.18	52.0	0.40	2.62	17.12	30.68	38.00
3	F <sub>11</sub>	4	<i>Aptuda aristata</i> , Linn. .	8.47	1.11	8.18	1.80	7.00	28.27	55.8	0.65	8.5	15.56	32.62	36.30
4	F <sub>11</sub>	5	<i>Schizachyrium brevifolium</i> , Nees.	9.14	0.75	12.10	1.40	4.68	26.11	55.7	0.70	2.34	14.86	32.86	35.66
5	F <sub>11</sub>	6	<i>Amphlophus glabra</i> , Stapf, var <i>glabra</i> .	6.24	0.91	8.48	2.22	5.65	22.8	60.9	1.11	2.82	12.54	35.98	40.02
6	F <sub>11</sub>	7	<i>Opismenus burmanni</i> , Beauv.	7.17	2.10	14.91	1.85	18.18	20.70	49.9	0.87	6.56	11.39	29.44	36.27

All these grasses possess good fodder value. F<sub>11</sub> is better than others. They are as good as elephant grass (green).

(11) *Miscellaneous.*—*Floating, Chaibassa division.*—Attempts are being made to make the Roro river floatable for the 12-14 miles stretch from the Protected Forest 30 to Chaibassa. Four floats of *salai* were made at Roro, and a raft of 10 poles of 30'-32' length was tied to them for experimental floating. Several sharp bends in the river were met with, which could not be negotiated by such long poles, and it was found necessary to cut them in two. The raft reached Chaibassa the following day. If floating is to become feasible, the curves in the river must be widened, the rapids must be cleared, and launching must be delayed until there is a suitable height of water. The river has since been treated as far as Barabassa near Baipi, and 200 sal poles have been stacked ready for further trials this year. The total expenditure incurred was Rs. 299-0-0.

## CENTRAL PROVINCES AND BERAR.

### GENERAL.

This part deals with the experimental work connected with the utilization and marketing of forest products, and the general commercial activities of the Forest department. The work is in charge of the Forest Utilization Officer, Khan Sahib Abdus Salam, Extra Assistant Conservator of Forests, who held charge of the post throughout the year under report.

### EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

New markets for electric transmission poles of teak and *Polyalthia cerasioides* were opened up during the year.

*Saw Mill.*—The Allapilli Saw Mill turned out 81,442 (66,560) cubic feet of sawn timber. The sales compared as under :—

	Quantity.	Amount.
	C. ft.	Rs.
Logs . . . . .	177,440 (155,631)	2,32,443 (1,93,123)
Sawn timber . . . . .	78,346 (70,111)	1,32,012 (1,19,849)
TOTAL . . . . .	255,786 (225,741)	3,64,455 (3,12,972)

The details are given below :—

(1) *Logs.*

Kind of produce.	Class.	Quantity.	Amount.	Average rate per c. ft.
		C. ft.	Rs.	Rs. A. P.
Teak logs . . . . .	1	732	1,640	2 6 3
Do. . . . .	2A	78,808	1,24,104	1 9 3
Do. . . . .	2B	71,106	89,072	1 4 1
Rough squared Ain (1) . . . . .	..	10,193	7,144	0 11 3
Shisham (2) . . . . .	..	3,787	2,643	0 11 2
Haldu (3) . . . . .	..	3,060	2,441	0 12 9
Garari poles (4) . . . . .	..	4,155	1,066	0 4 1
Teak poles . . . . .	..	5,496	3,826	0 11 2
Buriya poles (5) . . . . .	..	303	303	1 0 0
R I-c Bamboos . . . . .	..	1,000	6	..
TOTAL . . . . .	..	178,440	2,32,445	..

(1) *Terminalia tomentosa.*

(2) *Dalbergia latifolia.*

(3) *Adina cordifolia.*

(4) *Cleistanthus collinus.*

(5) *Xylia xylocarpa.*

(2) *Sawn Timber.*

Kind of produce.	Class.	Quantity.	Amount.	Average rate per c. ft.
		C. ft.	Rs.	Rs. A. P.
<i>Standard sizes.</i>				
Teak scantlings . . . . .	1	15,764	35,786	2 4 4
Do. . . . .	2	25,297	45,148	1 12 6
Do. . . . .	3	10,417	15,061	1 7 2
Teak battens . . . . .	1	2,039	3,150	1 6 9
Do. . . . .	2	5,425	6,783	1 4 0
Do. . . . .	3	4,530	4,760	1 0 10
Planks . . . . .	1	3,406	10,748	3 2 6
Slabs . . . . .	1	165	427	2 9 5
Ceiling planks . . . . .	1	16	49	3 0 10
<i>Underrizes and Mill waste.</i>				
Teak scantlings . . . . .	..	6,762	6,595	0 15 8
Teak battens . . . . .	..	4,116	2,786	0 10 10
Teak planks . . . . .	..	449	769	1 11 5
Other species . . . . .	..	1	1	1 7 9
TOTAL . . . . .	..	76,347	1,32,013	..

*Sleepers.*—This was the second year of the three-year contract and no difficulty was experienced in complying with the indent. A larger number of contracts was undertaken during the year and receipts compare as under :—

Contracts undertaken . . . . .	25 (14)
Number of sleepers . . . . .	95,167 (90,051)
Value . . . . .	Rs. 2,40,220 (2,09,789)

*Hand Sawing—Sal.*—The band sawing of surplus timber into small dimension stocks was continued in all the sal divisions. The quantity turned out during the year was 87,849 c. ft. (90,769 c. ft.).

*Teak.*—Hand sawing in the Bori coupes was continued, and 22,076 c. ft. of small sizes were sawn and sent to Taku depot. The market for this timber continued to be good. Similar operations were also revived in western Hoshangabad and the material fetched good prices.

Experimental sawing of logs into squares at Ellichpur depot proved successful and encouraging prices were received.

*Paper Pulp.*—The firm of Messrs. Narrondas Manordas of Bombay are examining the possibilities of erecting a pulp factory utilizing *Dendrocalamus strictus* as its raw material and the vicinity of Chanda has been suggested as a possible site, in view of the fact that the essential conditions as regards water, lime, coal, power, adequate raw material, labour, land, etc., appear to be fulfilled. As both Chanda and Ballarshah are on the broad gauge railway the necessary chemicals can also easily be imported via Calcutta, Madras or Bombay, and the export of the manufactured pulp and paper will also be equally easy. Representatives of the firm visited Ballarshah in January and appear to have been satisfied with regard to the suitability of the site. A rough trace of the forest areas has been supplied to them to facilitate a survey of the areas under bamboo, for which work the services of an experienced Ranger is to be placed at their disposal free of charge.

*Plywood.*—A representative of a Delhi firm has shown a desire to erect a plywood factory for the utilization of *salai* (*Boswellia serrata*). A possible site near Khirkiya on the G. I. P. Railway has been suggested as the result of an interview of the interested party with the Chief Conservator of Forests, C. P., and the Inspector General of Forests. Preliminary information required by the firm regarding the supply of raw material is being collected from Nimar, Melghat, Hoshangabad and Betul divisions, and the utilization of *laurel* (*Terminalia tomentosa*) and *haldu* (*Adina cordifolia*) has also been suggested.

*Match Industry.*—The Chanda Match Works continued to work throughout the year. The factory turns out 100 grosses of match boxes a day. The *semal* of North Chanda division supplied at concessional

rates is not found to be satisfactory for splints owing to its brittleness and brownish colour. The Manager is prepared to try other soft wood species but these are not available in commercial quantities. The Silviculturist was consulted, and his suggestion to experiment with *Hymenodictyon excelsum* as also to colour the splints has been tried with satisfactory results.

*Gun Carriage Factory*.—One order for 3,195 cubic feet of sal logs valued at Rs. 3,738 was undertaken during the year and supplied from Mandla, Balaghat and Raipur divisions, and another for sawn teak worth Rs. 764 was supplied from South Chanda division.

#### MISCELLANEOUS TIMBERS.

*Garari (Cleistanthus collinus)*.—The demand for poles of this species was steady, 3 orders for 2,100 poles were undertaken and supplied from South Chanda division. Efforts to develop the market were continued.

*Gardenia latifolia*.—One wagon load of this wood from North Chanda division was supplied to a cabinet making firm in Navsari.

*Haldu (Adina cordifolia)*.—Orders to the extent of 1,200 cubic feet of this timber were undertaken during the year and supplied from South Chanda division. Demand for this species continued on a limited scale.

*Maida lakri (Litsaea sebifera)*.—The sale of this species in the Chhindwara division realised Rs. 45 against Rs. 20 in the previous year.

*Polyalthia cerasoides*.—A new market for the poles of this species was created during the year and negotiations for placing orders were in progress. The demand is sure to increase if supplies are possible.

*Saja (Terminalia tomentosa)*.—286 cubic feet of this species were collected and sold by auctions at Khirkiya. Orders for rough squared logs to the extent of 1,500 cubic feet were undertaken and supplied from South Chanda.

*Salai (Boswellia serrata)*.—A firm in Bombay was supplied with samples of salai wood from Nimar.

*Semal (Bombax malabaricum)*.—The auction sales of this wood fetched better prices, giving an average of Rs. 9-14-7 per tree as compared with Rs. 7-9-9 in the previous year.

*Suriya (Xylia xylocarpa)*.—A wagon load of this timber was supplied to the Nizam's State Railway from South Chanda division.

*Tinsa (Ougeinia dalbergioides)*.—There was a good demand for this timber, and 7,012 cubic feet collected at Taku depot during the year were sold readily. Small quantities of poles were collected in rough squared form at Ellichpur depot and were sold by auction at satisfactory prices.

*Pit-props.*—Orders for pit-props amounting to Rs. 10,520 were secured from various collieries during the year and supplied from Hoshangabad, Mandla, Balaghat and Chanda division. The demand for pit-props of sal has fallen off as this species is said to deteriorate rapidly.

*Electric transmission poles.*—A new business was developed by opening up a market for long teak poles. An order from Messrs. Callenders' Cable Construction & Co. Limited, of Bombay, was undertaken, and 383 poles supplied at Itarsi before the close of the year. Small quantities were also collected at Ellichpur and Khirkiya depots and disposed of by auction. The following table shows the number of poles handled during the year and the amount realised :—

Depots.	No. of poles.	Quantity c. ft.	Revenue realised.
			Rs.
Ellichpur . . . . .	79	406	425
Khirkiya . . . . .	95	..	342
Itarsi . . . . .	383	2,585	3,181
TOTAL .	557	..	3,947

*Charcoal.*—The charcoal industry is making headway throughout the province. To encourage the use of "Frikilns" (a kiln invented at Dchra Dun for dry conversion of wood into charcoal), several merchants were persuaded to make trials. So far, only two of them have obtained drawings with a view to have the kilns made locally. To give an impetus to the industry, the department is getting a 'Frikiln' made locally for demonstrating its use to the students at the Forest School, Balaghat, and to the public.

*Bamboos.*—The departmental exploitation of bamboos was continued in Kota, Sonakhan and South Loan, ranges of Bilaspur division, and a revenue of Rs. 34,827 (23,310) was realised.

#### TIMBER TESTING.

Samples of *Zizyphus jujuba*, *Zizyphus xylopyrus* and *Zizyphus rugosa* from Melghat and Nimar divisions have been supplied to the Timber Adviser to the High Commissioner for India for trial. The charcoal of these species is required for making gun powder. The results of the trials are not yet known.

*Gardenia latifolia*.—The Linen Industry Research Association, Research Institute, Lambeg, Autrim, Ireland, is in search of a substitute for boxwood for spinning rollers. *Gardenia latifolia* has been suggested by the Forest Research Institute. Four small samples were kiln seasoned at the Gun Carriage Factory, Jubbulpore, and supplied to the Director of the Association. Results of the tests are awaited.

*Salai (Boswellia serrata)*.—Four logs of this species are being supplied from Nimar division to the Research Institute, Dehra Dun, for testing the suitability of this wood for veneers. The collection of the logs was in hand at the close of the year.

*Minor Forest Produce.—Lac.*—The amount of lac collected during the year is given below :—

Division.	Quantity.	
	Mds.	
Saugor . . . . .	1,204	(848)
Damoh . . . . .	2,953	(1,893)
Bilaspur . . . . .	39	(nil)
Balaghat . . . . .	nil	( 26)
Jubbulpore . . . . .	150	( 62)
Raipur . . . . .	143	(263)
Seoni . . . . .	347	(284)
Bhandara . . . . .	438	(250)
Hoshangabad . . . . .	67	( 63)
Chhindwara . . . . .	3	(nil)
TOTAL		5,344 (3,689)

The collection shows 50 per cent. increase in quantity but the receipts fell owing to a drop in the T. N. price from Rs. 24 to Rs. 15-8-0 per maund during the year. The revenue realised is detailed below :—

Circles.	Revenue.	
	Rs.	
Eastern . . . . .	30,460	(31,629)
Central . . . . .	4,605	(4,714)
Western . . . . .	66	(689)
Total . .		35,131 (37,032)

*Rusa grass*.—The demand showed a slight improvement as a result of which the leases fetched Rs. 5,319 as against Rs. 2,100 last year.

*Kulu gum.*—The demand for gum *karaya* from *Sterculia urens* was good but prices were low. The following quantities were exported from Bombay Port to various foreign markets during the year :—

Exported to—	Cwt.
United Kingdom . . . . .	1,173
Aden and Dependencies . . . . .	4
Germany . . . . .	29,793
France . . . . .	2,037
Belgium . . . . .	201
Netherlands . . . . .	7,063
U. S. A. via Atlantic coast . . . . .	35,685
<b>TOTAL</b>	<b>75,969</b>

An investigation started by the Silviculturist during the year to determine the best method of tapping the tree is described in the Silviculture portion of this report.

Departmental collection was continued in Sangor division which now includes Damoh also. Tapping on a small scale was undertaken in Nagpur-Wardha, Nimar, North Chanda, Jubbulpore, Bilaspur and Amraoti divisions.

Revenue realised from sales of the gum was :—

	Rs.
Eastern Circle . . . . .	9,719 (12,357)
Central Circle . . . . .	30 ( 599)
Western Circle . . . . .	418 ( nil )
<b>TOTAL</b>	<b>10,167 (12,956)</b>

*Katha.*—The demand for the manufacture of *katha* appreciated, and leases were sold in most divisions of the Eastern and Central Circles. Hoshangabad division in the Western Circle showed a marked improvement in receipts. Rs. 5,651 were realised as against Rs. 100 in the previous year. Total revenue from this source was as under :—

Circle.	Revenue. Rs.
Eastern . . . . .	11,180 (11,756)
Central . . . . .	3,800 ( 1,000)
Western . . . . .	5,651 ( nil )
<b>TOTAL</b>	<b>20,631 (12,756)</b>

*Leaves.*—The *bidi* industry in the province is on the rise. The demand for *tendu* (*Diospyros melanoxylon*) leaves continued to be good

throughout the year and resulted in better sales of the leases. A lease for collecting the leaves was sold for the first time in West Berar division. Total receipts were as under :—

Circle.	Revenue.
	Rs.
Eastern . . . . .	6,717 ( 5,292)
Central . . . . .	52,339 (56,135)
Western . . . . .	6,104 ( 1,895)
<b>TOTAL</b>	<b>65,160 (63,322)</b>

*Fruits and seeds.*—Revenue realised from the sales of miscellaneous fruits and seeds was Rs. 7,468 (Rs. 18,701).

*Grasses.*—*Sabai* grass was sold by annual leases realizing a revenue of Rs. 1,266 against Rs. 1,313 in the previous year.

*Harra (Myrabolans).*—The prevailing prices were as under :—

Particulars.	March 1936.	March 1937.	July 1937.	Sept. 1937.	Dec. 1937.	March 1938.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Jubbulpore average . . .	1 4 0	1 11 0	1 7 0	1 12 0	1 14 0	1 6 0
Jubbulpore No. 1 . . .	1 6 0	1 14 0	1 14 0	2 4 0	2 12 0	1 12 0
Crushed No. 1 . . .	2 6 0	3 2 0	3 2 0	3 2 0	3 12 0	3 4 0

Exports to foreign markets from Bombay Port during the past 3 years were as under :—

Year.	Quantity.
	Cwt.
1935-36 . . . . .	771,408
1936-37 . . . . .	545,553
1937-38 . . . . .	560,072

The contract for the Balaghat division was sold for a period of 3 years. This change was well received by the contractors and resulted in better revenue. Revenue realised from this source during the year was :—

Circle.	Revenue.
	Rs.
Eastern . . . . .	22,496 ( 6,485)
Central . . . . .	1,158 ( 335)
Western . . . . .	618 ( nil )
<b>TOTAL</b>	<b>24,272 ( 6,820)</b>

## MISCELLANEOUS.

*Lorry transport.*—The Allapilli Timber Transport Company worked satisfactorily throughout the year. It transported from Allapilli to Ballarshah—a distance of 62 miles—260,963 (219,695) cubic feet of timber during the year.

Mechanical transport is gradually but steadily increasing amongst contractors. Five private lorries in Balaghat, two in the Melghat, one in Hoshangabad and two in Nagpur-Wardha divisions, were employed for transport of sleepers, timber, bamboos and charcoal from forest to rail-head at the ordinary cart wages paid by the department or by forest contractors. This is a healthy sign, and it is expected that in due course the people of the province will learn to undertake bigger ventures.

*Railway concession.*—As Taku, Timarni and Khirkiya depots are being visited by merchants from distant markets of Northern India and Central India, the Railway authorities have been approached to consider the possibilities of stopping Mail and Express trains at these stations.

*Lahore exhibition.*—One merchant of Lahore exhibited at his own expense furniture made from Allapilli teak at the Lahore Exhibition held in 1938.

*All-India fibre exhibition, Calcutta.*—Specimens of fibre of the following species were supplied to the Commercial Museum, Calcutta, from various divisions for the All-India fibre exhibition held at Calcutta in 1938 :—

*Bauhinia malabarica*, *B. racemosa*, *B. vahlii*, *Butea frondosa*, *Careya arborea*, *Ficus bengalensis*, *Grewia hirsuta*, *G. tiliaefolia*, *Helicteres isora*, *Hymenodictyon excelsum*, *Kydia calycina*, *Ougenia dalbergioides*, *Phœnix acaulis*, *Pollinidium binatum* (*Ischæmum angustifolium*), *Sterculia urens*, *S. villosa*, and *Thespesia lampas*.

## MADRAS.

## I.—GENERAL WORK OF ADMINISTRATION.

The Forest Utilization Officer continued to be in charge of the work connected with the utilization of forest produce and studying market conditions, attending to research and propaganda. He also looked after the organisation and supply of track and special-sized sleepers to the Railway and of timber supplies to Government departments and other special markets.

## II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

(1) *Sleepers*.—Joint annual inspections with railway officers of the experimental treated and untreated and test length sleepers laid in the several section of the South Indian Railway and M. and S. M. Railway, were made as usual. The species inspected were :—

<i>Dipterocarpus indicus.</i>	}	Treated.
<i>Cullenia excelsa.</i>		
<i>Eugenia gardneri.</i>		
<i>Pæciloneuron indicum.</i>		
<i>Pæciloneuron indicum.</i>	}	Untreated.
<i>Eugenia gardneri.</i>		
<i>Dalbergia latifolia.</i>		
<i>Hopea parviflora.</i>		
<i>Mesua ferrea.</i>		
<i>Xylia xylocarpa.</i>		

The inspection of *Hardwickia binata* sleepers laid in the Godavari district had to be postponed for want of time.

(2) *Wood preservation*.—The question of the supply of Ascu treated wooden poles to the Electricity Department was investigated. Definite action has not yet been taken though proposals have been made to Government for the installation of an Ascu or Creosoting plant, and Government orders are awaited. In the meantime arrangements have been made to supply untreated teak and miscellaneous hardwood poles to the Electricity Department.

(3) *Osmose wood preservative*.—The Kodaikanal Municipality have purchased and erected transmission poles of *Pinus insignis* treated with Osmose preservative in Kodaikanal, and the results have to be watched.

(4) *Timber seasoning*.—The question of proper seasoning of hardwood sleepers has again been taken up by the Department, and it is proposed to start an experiment on the lines indicated by the Forest Research Institute, Dehra Dun.

(5) *Strength tests*.—The results of strength tests on pine poles sent from the Kodaikanal plantations, Madura division, have not yet been received from the Forest Research Institute, Dehra Dun.

The report of strength tests of *Palmyra* poles sent from Cuddapah North has been received. The results indicate that *Palmyra* poles are suitable for electric transmission poles and are about equal to sal poles in the matter of strength.

(6) *Paper pulp*—*Botha* grass (*Cymbopogon coloratus*).—The semi-commercial tests made at the Forest Research Institute, Dehra Dun, on the suitability of *botha* grass for paper pulp indicate that this is suitable for the production of cheap grades of paper with an admixture of a percentage (about 25 per cent.) of some long-fibred pulp such as that of bamboo.

(7) Statistics regarding the approximate quantity of bamboos and grasses available in the forest divisions of this Presidency were collected and submitted to the Chief Conservator of Forests, for communication to the Forest Research Institute, Dehra Dun.

(8) With a view to find out the importance of growth rings in grading and utilization of timbers, teak logs from thinnings from Amarampalam range, Nilambur division, were sent for test to the Forest Research Institute, Dehra Dun. The first consignment was lost by the Railway. Another consignment is now being sent.

(9) Authentic specimens of wood, and botanical specimens of various timbers required by the Forest Research Institute, Dehra Dun, are being sent to the Forest Research Institute.

(10) *Wood working*.—(a) *Shuttles*: With a view to find out timbers suitable for shuttle manufacture, arrangements have been made for the supply of *Mesua ferrea*, *Hopea parviflora*, *Anogeissus latifolia*, *Pterospermum rubiginosum*, *Pæciloneuron indicum* and *Hardwickia binata*, for test at the Forest Research Institute, Dehra Dun.

(b) *Timber resistant to teredo attack for harbour works*: Supplies of *Bischofia javanica* from Mangalore North division have been made for practical tests in the Vizagapatam, Madras and Cochin Harbour works, in order to test their power of resistance to the teredo borer.

(c) *Drawing boards*.—Samples of *Canarium strictum*, *Lophopetalum wightianum* and *Hymenodictyon excelsum* were sent to Messrs. Barton and Co., Bangalore, for test, but the firm has stated that they were not suitable for making drawing boards.

(d) *Motor bus bodies*.—The Joint Timber Advisory Officer, New Delhi, was interested in the use of possible substitutes for *Dalbergia sissoo* in motor lorries. The names of timbers used by the local firms, viz., benteak (*Lagerstræmia lanceolata*) for bottom frames and bodies, *Bombax malabaricum* for roofing (covered with galvanised iron) teak and white cedar (*Dysoxylum malabaricum*), were communicated to him.

(e) *Match manufacture*—*Evodia roxburghiana* was reported by the Western India Match Co. as being good for splints; *Ailanthus malabarica* is also very useful in match manufacture, but supplies of *Ailanthus* are reported to be scarce.

(f) *Wooden handles*.—Messrs. Coondoo Paul and Co., Calcutta, were interested in *Grewia tiliaefolia* for the manufacture of tool handles. This firm was supplied with samples from the Nilgiris division, and their report is awaited.

(g) *Novelty brush backs*.—Samples of figured teak, rosewood, poon, laurel, gluta, red sanders, pali and sandalwood are being sent to the Indian Trade Commissioner, U. S. A., Calcutta, in response to an enquiry forwarded by the President, Forest Research Institute, Dehra Dun.

(h) *Pencil manufacture*.—Small samples of the following timbers were supplied to the Madras Pencil Factory for test as possible pencil woods :—

- |                                      |                                    |                            |
|--------------------------------------|------------------------------------|----------------------------|
| 1. <i>Holigarna arnottiana</i> .     | 11. <i>Callitris rhomboidea</i> .  |                            |
| 2. <i>Premna tomentosa</i> .         | 12. <i>Swietenia macrophylla</i> . |                            |
| 3. <i>Trewia nudiflora</i> .         | 13. <i>Pinus insignis</i> .        |                            |
| 4. <i>Bombax malabaricum</i> .       | 14. <i>Pinus attenuata</i> .       |                            |
| 5. <i>Sterculia urens</i> .          | 15. <i>Pinus maritima</i>          | } Results<br>await-<br>ed. |
| 6. <i>Hymenodictyon excelsum</i> .   | 16. <i>Pinus ponderosa</i>         |                            |
| 7. <i>Pterospermum rubiginosum</i> . | 17. <i>Cedrela odorata</i> .       |                            |
| 8. <i>Spondias mangifera</i> .       | 18. <i>Eugenia alternifolia</i> .  |                            |
| 9. <i>Ilex wightiana</i> .           | 19. <i>Cedrela toona</i> .         |                            |
| 10. <i>Salix tetrasperma</i> .       |                                    |                            |

The firm reported that none of them is suitable except the last five on which tests have not been completed.

### Timber Testing.

(11) *Special tests on deep beam designs*.—Teak B. G. sleepers required for special tests on deep beam designs in the Forest Research Institute, Dehra Dun, are being supplied from the Nilambur division.

(12) *Strength tests*.—*Casuarina* poles for electric transmission lines will shortly be supplied to Dehra Dun forest, from the Nellore division.

(13) A sample of hammer handle was sent to the Forest Research Institute, Dehra Dun, by Messrs. Curzon and Co., Madras. On examination by the Wood Technologist, Dehra Dun, it was found to be made of *Atalantia* species. Botanical specimens of the woods are required by the Forest Research Institute to confirm this identification. It is reported that the handles tested have given very promising results and are comparable with hickory.

The identification has not been confirmed as yet. A sample of wood reported to bear a resemblance to this piece was sent to Dehra Dun but it was not the correct timber. Further attempts are being made to find the right species.

### *Commercial activities.*

(14) *Track sleepers*.—30,000 B. G. and 17,000 M. G. hardwood sleepers were supplied to the South Indian Railway at the rate of Rs. 6 per B. G. and Rs. 2-12-0 per M. G. affording a revenue of about Rs. 2,26,750.

(15) *Teak special sized sleepers*.—The contract for the supply of teak special sized sleepers was renewed by the South Indian Railway for another two years from April 1937, and 17,038 sleepers affording a revenue of Rs. 1,73,283-0-0 were supplied during the year.

(16) *Timber Market*.—The results of auction sales held by the District Forest Officers in the Wynaad, Coimbatore South, and Nilambur divisions were very satisfactory; prices maintained a high average and there was competition among the bidders.

The prices realised for red sanders in the Cuddapah and Chittoor divisions were below normal, due to want of demand in the Japanese market. This is only to be expected under present conditions.

(17) This Department participated in the All-India Khadi and Swadeshi exhibition in Salem and Calicut, and in the Madras Park Fair exhibition. The exhibitions attracted many visitors and enquiries were received for various forest products. Sandalwood, honey collected departmentally, and lac products were also sold in the exhibitions.

Mr. Scott, Joint Timber Advisory Officer to the Railway Board, New Delhi, visited the Madras Presidency and his note on revised specifications for sleepers is being considered by this Department. From the Forest Research Institute at Dehra Dun, Mr. Trotter, the Utilization Officer, Mr. Bhargava the Paper Pulp Expert, and Dr. Kapur, Officer in Charge of the Seasoning Section, all visited this Presidency, and discussions were held with them on various utilization problems relating to Madras.

### *Minor Forest Produce.*

370 candies of *Nux vomica* seeds, collected departmentally in the Nellore division, were sold in auction at Rs. 8-4-0 per candy against Rs. 11-4-0 during the previous year.

*Tans*.—The question of extending the cultivation of *avaram* (*Cassia auriculata*) and the growing of wattle (*Acacia decurrens*) in suitable localities has been engaging the attention of the Department. The ruling

prices of local tan barks and the imported wattle bark in the Madras market are compared below :—

	Cassia auriculata.	Cassia fistula.	Wattle bark.
	Per ton.	Per ton.	Per ton.
	Rs.	Rs.	Rs.
April 1937 . . . . .	130	72	135
May 1937 . . . . .	114	67	125
June 1937 . . . . .	94	54	125
July 1937 . . . . .	103	54	125 to 130
August 1937 . . . . .	96	54	125
September 1937 . . . . .	90	63	125 to 130
October 1937 . . . . .	94	54	130 to 135
November 1937 . . . . .	90	54	127½ to 135
December 1937 . . . . .	99	58	130
January 1938 . . . . .	90	54	130 to 135
February 1938 . . . . .	94	54	128 to 130
March 1938 . . . . .	81	60	131

*Avaram* (*Cassia auriculata*) experimental plots.—The results obtained by the analysis of bark from two year old coppice shoots of *avaram*, grown in the experimental plots in Vizagapatam District, have not yet been received from the Leather Research Chemist to whom samples were sent in September 1937.

Analytical examination of *avaram* (*Cassia auriculata*) bark from trees of varying ages grown in our experimental plantations, one to five years in age, has shown that the quality of the bark depends on its tannin content, and not on its age. One year old bark from vigorous shoots has been found to be richer in tannin than 2 or 3 year old bark from thin wiry shoots. As a rule, bark from shoots of pencil thickness, irrespective of their age, is good for tanning purposes. Such one year old bark contains 16 per cent. to 20 per cent. tannins, and the rise in the tannin content of *avaram* bark from the first year to the third year, is between 2 and 3 per cent. only.

Results of analyses of *konnai* bark (*Cassia fistula*) from coppice shoots one to six years old, from Rajahmundry, showed that bark from coppice shoots 4 to 5 years old contained the maximum quantity of tannin. In the tanners' opinion, very thin bark was useless for tanning purposes, as also very thick bark from old trees.

*Terminalia arjuna*.—In connection with the study of local tan stuffs, the Leather Research Chemist, Leather Trades Institute, Madras, was supplied with samples of *Terminalia arjuna* bark and fruits. The results of the analyses received are as below :—

	Bark.	Fruits.
Tans . . . . .	15.84	8.16
Non tans . . . . .	8.16	5.76
Insolubles . . . . .	68.51	10.81
Moisture . . . . .	7.49	75.27

#### Miscellaneous.

*Beedi leaves*.—Leaves of *Diospyros melanoxylon* are largely used in making 'heedies'—the Indian substitute for cigarettes. The process of drying and curing the *beedi* leaves after their collection was examined, and the information gathered from the more important centres of collection was sent to the Conservator of Forests, Ceylon, on his request.

*Katira or karaya gum*.—This is the gum obtained from *Sterculia urens*. Inquiries for supply of this gum were received from Messrs. Ispahani and Sons, Madras, and from another firm in Cocanada. Various samples of the gum collected in Upper Godavari division were supplied to Messrs. Ispahani and Sons, Madras, who preferred the white variety. This firm and the other in Cocanada were put in touch with the District Forest Officer.

*Walking sticks*.—*Pociloneuron indicum* saplings are used in the manufacture of walking sticks in Mangalore. Both finished and raw sticks exhibited in the Calicut Exhibition were quickly sold out. This brought in a trial order from Mr. Edwards in Coimbatore, who was specialising in the manufacture of walking sticks from canes, bamboos and wood.

*Lac*.—Cultivation of lac in the Cumbum range, Madura division was continued. The yield was sold locally as scraped lac at Rs. 14 per maund of 82 lbs. and washed lac at Rs. 20 per maund *ex-depot*. 2,735 lbs. of scraped lac and 3,854 lbs. of seed lac sold during the year brought in a revenue of Rs. 1,696. The price of lac in the Calcutta market dropped during the year and this adversely affected our prices also which had to be reduced proportionately.

Lac produced in the Salem North division was used as usual in the manufacture of shellac, polish, varnish and other lac products. During the year, about 255½ gallons of lac polish were supplied to the Jails, 110 gallons to Messrs. Spencer & Co., Madras, and about 54 gallons to the P. W. D. and Industrial Schools, yielding a revenue of Rs. 1,751-4-9. Sales of lac products from the Departmental stalls in the exhibitions at Salem, Calicut and Madras Park Fair amounted to Rs. 572-15-6. Further samples of lac polish have been sent to the P. W. D., and it is hoped that orders will be forthcoming on a larger scale.

Her Excellency Lady Marjorie Erskine visited the Forest Department stall in the Park Fair Exhibition in December 1937, and was interested in the colourless lac polish prepared by the Department. Samples of colourless lac polish were sent to Government House, Madras.

The Kerala Soap Institute, Calicut, was supplied with several kinds of oil seeds, with a view to finding out their respective properties as a soap medium. The results of the experiments are awaited.

Attempts are being made to supply the Biochemist, Forest Research Institute, Dehra Dun, with *Lauraceae* seed fats containing lauric acid, which are reported to be coming into prominence.

An enquiry was received from a firm in Bomhay for the supply of barks of *Holigarna arnottiana* with a view to carrying out some experiments with the juice obtained from it. The juice of the plant is very poisonous and affects the skin of human beings.

Increased sales of some important Minor Forest Products, particularly honey and bees' wax are assured, some of the important Medical Institutions, both private and Government, have placed their annual indents with this Department for supplies of these products. The demand has on several occasions exceeded the supply, and the Utilization division is endeavouring to pool the resources of all the Forest divisions, to meet this increased demand.

## NORTH-WEST FRONTIER PROVINCE.

*Wood working.*—Sample sissoo logs (*Dalbergia sissoo*) cut from the Lower Swat canal banks, the management of which is now with the Forest Department, were sent to the Forest Research Institute for testing for veneers. It was found to be admirable as a decorative plywood, and offered no conversion or other difficulties. Examples of plywood made from this consignment were shown at the Forestry Section of the Lahore Exhibition.

## ORISSA.

### I.—GENERAL WORK AND ADMINISTRATION.

Owing to limited staff practically no work was possible.

### II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

The Jhankerhahali lac orchard in Samhalpur division has been practically closed down. The *kusum* (*Schleichera trijuga*) brood has died out. There remain 28 *palas* (*Butea frondosa*) trees which are bearing some lac. Orders were issued to the District Forest Officer, Parlakimedi division, to experiment with *kusum* lac cultivation.

In Barapahar division a sum of Rs. 400 was spent in blasting operations in the Mahanadi river. Floating of bamboos is now a practical commercial possibility ; and further improvements to the river bed may be left to private enterprise to undertake. In the same division successful experiments in floating were undertaken in minor rivers such as the Danta and Jira.

In Ganjam division an experiment was made during the year, departmentally, of floating 5,000 bamboos and 3 dugouts from Bontha range down the Bodonodi and Rushikulya River to Ganjam. The experiment was not successful. It was found that, except for periodical spates, even during the rains the rivers are too shallow and sluggish for floating. When spates do occur they are so sudden and of such short duration that the produce is only carried a short distance before becoming stranded again. Any steady flow in the rivers is diverted by anicuts into the reservoirs. The produce actually reached Ganjam but the cost had been too heavy to give a profit on sales.

The Divisional Forest Officer, Angul division, supplied samples of timbers to the Orissa Engineering School, Cuttack, a furniture Company in Cuttack, toy making businesses in Cuttack and the Salvation Army, Angul. No laurel wood was despatched to the High Commissioner for India, but at the close of the year an order for 750 c. ft., was received. Matchwoods from this division continued to be supplied to the Talcher Match Works.

Mr. H. Trotter, Forest Utilization Officer at the Forest Research Institute, Dehra Dun, visited Cuttack in January 1938 and gave advice on the erection of a seasoning kiln and other projects for development. Dr. S. N. Kapur, later in the year, paid a visit to Cuttack to give technical advice to the private firm interested in the erection of a seasoning kiln. This firm is now awaiting a decision on the site for the new Capital of Orissa before committing itself to the project. In the meantime, in Puri division, 100 teak logs have been collected from wind-fallen trees and stacked in a seasoning shed for supply to the seasoning kiln when erected.

The Public Works Department purchased an Ascu treatment plant for use on the new Koraput-Rhayagada road. Towards the close of the year Government issued orders that all Government Departments and institutes should give preference to local timbers in all works for which timber is required. This order should stimulate consumption of local timbers. It has to be regretted that although timber was offered to the Public Works Department on favourable terms for the construction of Ascu treated wooden culverts and bridges on the Rairakhol, section of the Cuttack-Samhalpur road, it was decided to put up masonry

or ferro-concrete structures. This decision will involve importing raw materials instead of utilising the products of the Province.

The terms of the proposed bamboo leases in Barapahar and Sambalpur divisions to the Orient Paper Mill Company were settled after discussions with representatives of the Company. In exchange for an undertaking by the Company to employ a percentage of Oriyas in their Mills, Government has agreed to give concessions in respect of the royalty payable. These concessions may amount in the course of the next few years to about 2 lakhs of rupees.

During the year Government gave instructions to investigate the possibilities of growing fruit trees such as oranges, lemons, and jack within forest areas. Few suitable sites within reserves have been found available, and these are almost all in localities supporting good forest. In view of the great risk of damage from the depredations of wild animals, and the difficulty of marketing fruit grown in forest reserves, the writer believes that large scale attempts to establish orchards within other than very open forest reserves are bound to prove a costly failure, and that, instead, efforts should be concentrated on encouraging villagers to grow fruit trees in waste lands and unreserves.

The Forest Department was also asked to investigate the possibility of irrigation schemes. The Labangi irrigation channel which was constructed in 1935 with funds supplied by the Civil Department was widened and improved. Some 10 acres of *toila* land were irrigated, and paddy grown thereon. A more extensive use is expected to be made in 1938-39.

## UNITED PROVINCES.

### I.—GENERAL WORK OF ADMINISTRATION.

After remaining in abeyance for six years the post of Forest Utilisation Officer was revived as a divisional charge as an experimental measure for a period of one year from October, 1937. A recommendation has recently been sent to Government asking for the renewal of the post for a further period of three years.

Mr. D. Stewart, O.B.E., Deputy Conservator of Forests, held charge of the post from 3rd October, 1937. He has been constantly on tour throughout the six months under report, and has visited most forest divisions in the United Provinces, and nearly all the big towns in the United Provinces with important markets for, and industries connected with, forest produce. He also paid two visits to the Forest Research Institute, Dehra Dun, and attended the Sleeper Pool Committee meeting at Delhi in November, 1937.

## II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

### (1) *Wood technology.*

2. Sections of the stem of *Sterculia urens* were sent to the Wood Technologist, Forest Research Institute, in connection with experiments which are being conducted in Jhansi forest division with a view to discovering the best method of tapping this tree for *karar* gum, the old methods having led to deterioration and heavy mortality of the trees. A report has been obtained and experiments are being continued on the lines indicated by the Wood Technologist.

### (2) *Timber seasoning.*

3. (i) An experiment was started, in collaboration with the Forest Research Institute, with a view to following the career of a number of *Pinus longifolia* (*chir*) sleepers from the tree to the creosoting plant and later in the railway line. It is proposed to study the seasoning of the sleepers from the time they are cut right up to the time they are used, in order to get definite information on the amount and nature of their seasoning defects, and the rate of drying of the sleepers at various stages of seasoning, with a view to suggest ways and means of improving the seasoning of such sleepers, as well as of minimising seasoning degrade, which is alleged to be the cause of considerable rejections at the time of passing.

The Assistant Seasoning Officer, Forest Research Institute, visited the East Almora Forest division in October, 1937, to initiate the experiment and again paid a second visit to Tanakpur and East Almora division in February and March, 1938, in the same connection. A preliminary report on the subject was received from the Forest Research Institute in March, 1937, and the experiment is being continued.

4. (ii) A further experiment was started in collaboration with the Forest Research Institute and the Rohilkhund and Kumaon Railway to collect information on the seasoning of M. G. *sal* sleepers obtained from the United Provinces forests and laid in line in a moderately dry locality. The following points are being investigated :—

- (a) The exact amount of seasoning which sleepers undergo in a year's stacking in close-crib manner, and the seasoning degrade which occurs during this period.
- (b) The effect of seasoning for a year on the life of a sleeper and whether there is any benefit in seasoning *sal* sleepers before laying them in the line.

Lucknow was selected as the site for the experiment. The sleepers were divided into two lots of 500 each, one lot being laid in the line

immediately and the other lot being kept stacked in close-crib manner for a year under the shade of trees, preparatory to being laid in the line in the same locality as the first lot. The behaviour of the sleepers will then be noted periodically and a complete record of the life of each sleeper kept in order to arrive at the average life of the two lots of sleepers for comparative purposes.

### (3) *Timber testing.*

5. The following consignments of timber were sent to the Forest Research Institute for test under different projects.

(1) Thirty-five billets of *Anogeissus pendula* (*kardar*) from Jhansi division for test under Project No. O, to ascertain its suitability for tool handles, shuttles, etc. A preliminary test carried out at the Forest Research Institute with green specimens of this timber indicated that it is very much superior to ash and practically equal to hickory in strength qualities. As there are considerable supplies of the timber available in Jhansi division, the results of the final test at the Forest Research Institute are awaited with interest.

(2) Consignments of *sal* timber from several divisions in the United Provinces have been sent to the Forest Research Institute in connection with the all India Project to determine the relative strengths of *sal* from different localities. It has also been arranged that these consignments of *sal* from different localities in the United Provinces should also be subjected to durability tests.

### (4) *Wood preservation.*

6. The only departmental work done was the Ascu treatment of some tramway sleepers for the Haldwani division tramway in the small Ascu treating plant installed in that division last year. Some fencing posts were also treated in the same plant. This was done on a comparatively small experimental scale, and both the sleepers and fencing posts are being kept under observation.

During the year the Forest Utilisation Officer inspected a considerable number of Ascu treated *sal* and *chir* electric transmission poles which have been erected in various parts of the United Provinces during the last few years. The *sal* poles, which number approximately 10,000, were erected mostly by the United Provinces Hydro-Electric department between 1935 and 1937 principally on short distribution lines to tube wells. The only lot of *chir* poles is in the town of Fyzabad, the entire electric distribution system of which was done by Messrs. Callender's Cable and Construction Co., Ltd., in 1937, with Ascu treated *chir* poles.

During the year about 1,000 *chir* poles for electric distribution lines were supplied to Messrs. Callender's Cable and Construction Co., Ltd. These are being Ascu treated in the firm's plant at Bareilly.

7. It is too early yet to make any useful remarks about the behaviour of the Ascu treated poles hitherto erected in the United Provinces, but the necessity for maintaining adequate records and statistics with a view to watching the behaviour and ascertaining the effective life of these poles in the line is obvious. Such records and statistics for treated poles are maintained on a large scale in Europe and America, and the Forest Utilisation Officer is at present working out a scheme for maintaining similar records in the United Provinces in collaboration with the Forest Research Institute and the firms and Government departments which have installed the poles.

8. Owing to the present high price of steel poles the Forest Utilisation Officer has recently received numerous enquiries from Electric Supply Companies and others throughout the province about the possibility of supplying suitable wooden poles. This matter is now being actively taken up and a note has been issued to about forty different companies and electrical engineers detailing the arrangements which the United Provinces Forest department is prepared to make. Briefly the proposed system is that the department will arrange with forest contractors who purchase forest lots by auction to enter into voluntary agreements with Electric Supply Companies, etc., to deliver untreated poles up to specification at a price to be fixed before the auctions. Passing of the poles will be done at railway stations by Forest department passing officers and payment made by the companies direct to forest contractors after the poles are passed. The arrangements and method of preservative treatment are being left to the Electric Supply Companies concerned. No treatment will be done departmentally. The poles which are being recommended for use are fairly large size *sal* poles which are naturally straighter than small *sal* poles and can be obtained in larger numbers up to specification. Part of the sap wood can be trimmed from such poles in order to give greater straightness, and the cost of preservative treatment is reduced as the poles contain a fairly large amount of heart-wood which does not absorb preservative, and also does not require it.

#### (5) *Minor forest products.*

9. (i) *Karar gum from Sterculia urens*.—Departmental work in collecting this gum was undertaken in the Jhansi forest division and various methods of tapping adopted experimentally with a view to arriving at the best results. Departmental work was resorted to on account of the serious damage done to the trees by the destructive methods of tapping previously employed by contractors. The gum

collected departmentally was graded and good prices were obtained by auction in December 1937, which seems to show that it pays to grade the gum. Prices obtained at more recent auctions have been somewhat lower, apparently due to the fairly large amount of gum on the market.

(ii) *Lac*.—Prices for lac continued to be very low and a large number of the small shellac factories in Mirzapur have closed down as the present price of shellac makes production unprofitable.

#### (6) *Paper pulp*.

10. (i) *Experimental*. A consignment of about twenty tons of *ulla* grass (*Anthisteria gigantea*) was sent to the Upper India Couper Paper Mill Ltd., Lucknow, to test its suitability for making high class writing and printing paper on a commercial scale. The result of the test is still awaited. Previous tests with this grass at the Forest Research Institute on a semi-commercial scale were promising but inconclusive. It is estimated that about 48,000 tons per annum of this grass will be available at an economic price from the United Provinces forests.

Arrangements were recently made to send one and a half tons of *ulla* grass to the Forest Research Institute to test its suitability for making kraft paper, cheap wrapping paper and wall boards. At least one commercial concern in the United Provinces is interested in starting an industry to manufacture one or more of these products.

The experiments with regard to utilising *chir* pine billets for the manufacture of pulp suitable for kraft and cheap wrapping papers which are proceeding at the Forest Research Institute are also of considerable interest to the United Provinces as also the possibility of using *chir* pine billets and refuse for the manufacture of wall boards. At least one commercial concern is interested.

11. (ii) *Commercial*.—During the year the construction of a new paper mill, the Star Paper Mills Ltd., was started at Saharanpur and it is anticipated that the mill will start work very soon. This mill will be dependent on the *baib* grass supplies of the Western Circle, United Provinces, and has been granted by Government a long lease of these supplies for the manufacture of paper.

All the remaining *baib* grass supplies from the United Provinces forests are being utilised by the Upper India Couper Paper Mill Co., Ltd., Lucknow, the Shree Gopal Paper Mill, Jagadhri, and the Rohtas Industries Ltd. Paper Mill, Dehri-on-Sone.

The demand for *baib* grass supplies from the United Provinces forests is now very intense, both from paper mills and the cottage rope making industry. The question of artificial propagation of this grass on a fairly large scale, both inside and outside the forest areas, is under considera-

tion and is likely to be a very profitable proposition, both for supply to paper mills, the demand from which considerably exceeds the supply, and for the expansion of the existing rope making industry.

(7) *Tans.*

12. Nothing to record.

(8) *Wood working.*

13. There are no wood-working concerns in the United Provinces under the control of the Forest department but the Forest Utilisation Officer maintained touch with the two wood working institutes under the control of the Industries department at Bareilly and Allahabad and with all the principal commercial wood working concerns and the furniture making trade, with a view to assisting them in obtaining their requirements of timber at fair prices. The main difficulty is in arranging for adequate supplies of suitable timbers to the Bobbin Factory of the Indian Turpentine and Rosin Co., Ltd., at Clutterbuckganj both as regards quantities required and at prices which can allow Indian made bobbins to compete successfully against imported Japanese bobbins. The timber which makes the best bobbins is *Adina cordifolia* (*haldu*) but this timber has a higher value in the ordinary market than the bobbin industry can afford to pay. Available supplies are also inadequate for the bobbin industry in addition to the ordinary market. Another good timber for bobbins is *Hymenodictyon excelsum* (*baurang*) but the quantities available are very small. Efforts are being made to overcome these difficulties with a view to keeping the industry alive.

14. The sawmill of the Indian Turpentine & Rosin Co., Ltd., uses about one lakh cubic feet of *Bombax malabaricum* (*semal*) per annum for making packing cases, in addition to sawing up the various timbers required for bobbins, etc. Other two smaller privately owned sawmills at Lalkua and Haldwani utilise nearly a lakh of cubic feet of *semal* for packing cases.

The furniture trade, principally at Bareilly, uses considerable quantities of *Dalbergia sissoo* (*sisso*).

The Gun Carriage Factory at Jubbulpore takes considerable quantities of *sal*, *sisso* and *Holoptelia integrifolia* (*kanju*) from the United Provinces forests, and the Forest Utilisation Officer kept in close touch with the factory and with the Joint Timber Advisory Officer, Railway and Defence departments, about these supplies.

(9) *Miscellaneous.*

15. (i) *The Match Industry.*—There is a very heavy demand for *Bombax malabaricum* (*semal*) for splints and boxes from match

factories in the province, in fact the demand is now so great that it cannot be met in full in addition to supplying the demands of various sawmills which require *semal* for the manufacture of packing cases. The largest consumer of *semal* is the Western India Match Co. factory at Bareilly, but there are several other small Match factories at Bareilly, Cawnpore, Lucknow and Haldwani. The last two mentioned were opened during the year, and several enquiries were received regarding the possible supply of timber to other proposed new factories. In all cases, replies had to be sent discouraging these proposals, as supplies of suitable timbers do not exist in the province. The question of what steps are to be taken to ensure adequate future supplies of match timbers by making plantations on a considerable scale is now receiving the serious attention of the Forest department. There is at present a market in the province for about five to six lakhs cubic feet of *semal* timber per annum for matches and packing cases whereas the available supply does not exceed three and a half lakhs cubic feet per annum.

16. (ii) *Plywood and Veneers*.—During the year a Cawnpore firm proposed a scheme for the manufacture of commercial plywood *plus* decorative veneers and laminated boards, requiring about 400,000 c. ft. of *semal* and other timbers suitable for making cheap commercial plywood. The scheme was thoroughly investigated and ultimately had to be definitely discouraged so far as cheap commercial plywood is concerned, as the supplies could not be made available without cutting off existing supplies to match factories. So far as decorative veneers and laminated boards are concerned supplies of suitable timbers are ample but the firm considered that the manufacture of these without the addition of commercial plywood would not be a sufficiently attractive proposition financially. Other wood working concerns who already possess saw milling machinery are, however, being encouraged to take up the manufacture of decorative veneers and laminated boards. Some of them are definitely interested in the proposition and it is hoped that this industry will soon be started in the provinces.

Meanwhile the question of what steps should be taken to grow timbers on a large scale suitable for the manufacture of commercial plywood is engaging the serious attention of the department.

17. (iii) *Sleeper supplies to Indian Railways*.—The Indian Railways are the biggest individual customers of the United Provinces Forest department. For many years past the Tarai Group Sleeper Pool has bought about two and a half lakhs of metre gauge *sal* sleepers annually from the United Provinces forests. The system of supply, passing, and payment is on a semi-departmental basis, which has worked smoothly and to the mutual benefit of the Group and the Forest department. All passing of sleepers for the Group is done by the Forest depart-

ment passing officers and one of the duties of the Forest Utilisation Officer is to standardise sleeper passing throughout the province, and to maintain liaison with the Group on all matters affecting this sleeper supply. Relations with the Group continue to be most cordial.

During the year under report an arrangement similar to the Tarai Group arrangement was brought into force with the Northern Group Sleeper Pool for the supply of about 32,500 c. ft. bridge and crossing sleepers to the North Western Railway valued at about Rs. 72,400. The arrangement is working satisfactorily and it is hoped it will continue. Passing of sleepers is done by Northern Group passing officers.

The old three year contract for the supply of *chir* broad gauge sleepers to the North Western Railway through the Northern Group Sleeper Pool is under renewal for a further period of three years. The new contract is for an annual supply of 130,000 broad gauge sleepers at Rs. 3-2 per sleeper f.o.r. forest railway stations. These sleepers are creosoted at the North Western Railway treating plant at Dhilwan. Creosoted *chir* sleepers continue to give excellent service in the track.

18. (iv) *Railway freight rates*.—This matter has an important bearing on the United Provinces timber markets and prices, as the United Provinces forests are tapped by several railways, private and state owned, the freight rates on which differ considerably. The Forest Utilisation Officer is making a study of special cases in which reduction of freight rates would help markets, particularly for fuel, in certain towns in the United Provinces, and it is hoped that it will be possible to convince the railways concerned of the necessity for special rates in certain cases.

19. (v) *Enquiries and liaison*.—Numerous enquiries were answered regarding the availability and sources of supply of various timbers and other forest produce. Liaison was maintained with the Forest Research Institute, the Joint Timber Advisory Officer, Railway and Defence departments, Delhi, the Director of Industries, United Provinces, and all the wood working industries in the province.

20. (vi) *Minor Industries dependent on forest products*.—At the request of the United Provinces Government a survey was made during the year regarding steps which can be taken to foster and increase minor and village industries dependent on supplies of forest products and a report is in course of preparation.

## APPENDIX I.

*List of Provincial Forest Publications of 1937-38 (excluding the Forest Research Institute Publications).*

## ASSAM.

Flora of Assam, Assam Forest Record, Vol. II (Botany).

*Indian Forester—*

Hollock regeneration, by J. N. Das.

Aided natural regeneration of sal established, by R. N. De.

Grazing and its effect on simul regeneration, by J. B. Rowntree.

## BENGAL.

Nursery and Plantation Notes for Bengal, 4th edition, by C. K. Homfray, 1937.

Graphs giving Volume/Age for the more important species found in the Northern and Southern Bengal, compiled in the office of the Silviculturist, Bengal ; (Bengal Forest Bulletin No. 2).

List of Scientific Plots maintained by the Silvicultural Division, Bengal ; (Bengal Forest Bulletin No. 3).

*Indian Forester—*

History of the Management of the Darjeeling Forests, by E. A. C. Modder.

Kamrup method of natural regeneration of sal and the possibility of its application to Bengal, by R. I. Macalpine.

Note on the Dacca-Mymensingh Forest Division, by Y. S. Ahmad.

## BIHAR.

Bihar Grading Rules for timbers.

Floating a cheap means of transport.

Contour trenching at Bamiaburn.

Flood Problem in Bihar—need to enforce control measure.

A brief account of Bihar Timber.

A note on the seasoning of Indian Timbers.

*Indian Forester—*

The irrigation of dry hill sal areas.

State control over private forests in Finland, by J. N. Sinha.

## BOMBAY.

*Indian Forester—*

Note on *Casuarina equisetifolia* plantation in Karwar, by D. S. Kaikini.

Description of the Government Depot at Kodibag, by D. S. Kaikini.

The Future of Forests, by E. A. Garland.

Forests and Man, by E. A. Garland.

## CENTRAL PROVINCES.

*Indian Forester—*

Departmental collection of kulla gum (*Sterculia urens*) in Damoh division, by Kesar Singh.

Regeneration of frost-labile forests in the Central Provinces, by K. P. Sagreiya.

Departmental exploitation of forests in Nimar division, by S. A. Vahid.

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## MADRAS.

*Indian Forester—*

Regeneration and propagation of sandalwood, by S. Rangeswami.

Silvicultural experiments, by J. Banerji.

Secondary sources of moisture for the soil, by M. V. Laurie.

## ORISSA.

*Indian Forester—*

Results of coppicing, pollarding and pruning experiments to stimulate *Strychnos nux vomica* fruit production, by J. W. Nicholson.

## PUNJAB.

The depth and frequency of irrigation in plantations, by R. S. Chopra (*Punjab Forest Records*, Vol. 1, No. 4).

Propagation of *Karer*, by R. S. Chopra (*Punjab Forestry Notes*, No. 2).

*Phulai* (*Acacia modesta*, Wall.), by R. S. Chopra (*Punjab Forestry Notes*, No. 3).

*Harar* cultivation in the Punjab, by R. S. Chopra (*Punjab Forestry Notes*, No. 4).

Soil losses, by R. M. Gorrie.

Advantages of Irrigated Plantations, by R. M. Gorrie.

Soil erosion, by R. M. Gorrie.

Afforestation of villages in the Punjab, by R. M. Gorrie.

Punjab Forest Resources, by R. M. Gorrie and I. D. Mahendru.

Forests in Punjab Rural Life, by R. S. Chopra.

Commercial guide to Punjab timbers, by I. D. Mahendru.

Leaflet on air seasoning.

Soil erosion : an outline for practical teaching in schools, by R. M. Gorrie.

*Indian Forester—*

Erosion survey of the Uhl valley, by R. M. Gorrie.

Reclamation in the Pabbi Hills, by R. M. Gorrie.

Thinning practice in coniferous forests, by N. G. Pring.

Protection of *Prosopis juliflora* pods from attack by *Caryoborus gonagra*, by C. L. Kapur.

Results of silvicultural treatment of Bamboos in the Hoshiarpur division, by I. D. Mahendru.

Single tree silviculture in Indian conifers, by R. M. Gorrie.

A note on *Ulmus villosa* Brandis and on other elms in the N. W. Himalaya, by R. N. Parker.

The measurement of soil erosion and run-off, by R. M. Gorrie.

The Balsan State Forests, by N. G. Pring.

Two years old bamboo seedling, by Saeed Ahmad.

Collett's Flora Simlensis, by R. N. Parker.

Crown ratio in Indian Conifers, by R. M. Gorrie.

Stone bunds in erosion control, by R. M. Gorrie.

## UNITED PROVINCES.

Forest Pocket Book, 4th edition, by S. H. Howard.

Taungyas of the Saharanpur Forest division, by M. D. Chaturvedi, U. P. Forest Department Bulletin No. 10.

*Indian Forester—*

The Shelterwood coppice system, by W. T. Hall.

Large sal tree, by N. N. Sen.

Some notes on the Kamrup method of sal regeneration, by H. G. Champion.

A note on the bridge over the Ramganga at Kalagarh, by R. N. Brahmawar.

## APPENDIX II.

*Statement showing rank, designation and address of Forest officers employed exclusively on research work in the various Provinces during 1937-38.*

Serial No.	Name.	Designation.	Address.
1	Dr. N. L. Bor, Deputy Conservator of Forests.	Held the combined post of Botanical Officer and Silviculturist, Assam, from 1st April 1937 to 10th October 1937.	Shillong.
2	Mr. R. N. De, Deputy Conservator of Forests.	Held the combined post of Botanical Officer and Silviculturist, Assam, from 11th October 1937 to 31st March 1938.	Do.
3	Mr. S. M. Deb, E. A. C. of Forests.	Forest Utilisation Officer, Assam.	Gauhati.
4	Mr. J. C. Nath, Deputy Conservator of Forests.	Silviculturist, Bengal . .	Darjeeling.
5	Mr. S. C. Chatterjee, E. A. C. of Forests.	Assistant Silviculturist, Bengal, (1st April 1937 to 30th June 1937 and 1st December 1937 to 31st March 1938).	Do.
6	Mr. S. K. Datta, E. A. C. of Forests.	Assistant Silviculturist, Bengal (1st July 1937 to 30th November 1937).	Do.
7	Mr. C. T. Trigg, Deputy Conservator of Forests.	Forest Utilisation Officer, Bengal (1st April 1937 to 24th November 1937).	Calcutta.
8	Mr. S. Chaudhuri, Deputy Conservator of Forests.	Forest Utilisation Officer, Bengal (25th November 1937 to 31st March 1938).	Do.
9	Mr. W. D. M. Warren, Deputy Conservator of Forests.	Forest Research Officer, Bihar	Ranchi.
10	Mr. K. P. Sagreiya, Deputy Conservator of Forests.	Silviculturist, C. P. . .	Nagpur.
11	Khan Sahib Abdus Salam, E. A. C. of Forests.	Forest Utilisation Officer, C. P.	Do.
12	Mr. A. L. Griffith, Deputy Conservator of Forests.	Silviculturist, Madras . .	Ootacamund.
13	Mr. M. Srinivasa Raghvan, E. A. C. of Forests.	Assistant Silviculturist, Madras	Do.
14	Mr. Mohd. Abdul Hafiz Sahib	Forest Utilisation Officer, Madras.	Madras.

APPENDIX II—*contd.*

Serial No.	Name.	Designation.	Address.
15	Mr. J. W. Nicholson, Conservator of Forests.	Carried out the duties of Research Officer in addition to his own duties.	Angul.
16	Dr. R. M. Gorrie, Deputy Conservator of Forests.	Divisional Forest Officer, Silvicultural Research Division, Punjab (1st April 1937 to 31st January 1938).	Lahore.
17	Mr. I. D. Mahendru, E. A. C. of Forests.	Divisional Forest Officer, Silvicultural Research Division, Punjab (1st February 1938 to 31st March 1938).	Do.
18	Mr. I. D. Mahendru, E. A. C. of Forests.	Attached Officer, Silvicultural Research Division, Punjab (1st April 1937 to 31st January 1938).	Do.
19	Mr. R. S. Chopra	Attached Officer, Silvicultural Research Division, Punjab.	Do.
20	Mr. F. C. Ford-Robertson, Deputy Conservator of Forests.	Silviculturist, U. P. (1st April 1937 to 9th May 1937).	Naini Tal.
21	Mr. E. C. Mobbs, Deputy Conservator of Forests.	Silviculturist, U. P. (10th May 1937 to 31st March 1938).	Do.
22	Mr. M. A. Kakazai, E. A. C. of Forests.	Assistant Silviculturist, U. P. (1st March 1937 to 12th February 1938).	Do.
23	Mr. D. Stewart, Deputy Conservator of Forests.	Forest Utilisation Officer, U. P. (from 3rd October 1937 to 31st March 1938).	Bareilly.

## APPENDIX III.

*Publications of the Forest Research Institute, Dehra Dun,  
available for Sale.*

## SILVICULTURE SERIES.

## BULLETINS (Old Series).

	PRICE. Rs. A. P.
*4. <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry . . . . .	0 12 0

## PAMPHLETS.

*6. Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger . . . . .	1 0 0
*8. Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia . . . . .	0 10 0
*9. Tables showing the Progress in Working Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author . . . . .	0 10 0
*16. Note on the Best Season for Coppice Fellings of Teak ( <i>Tectona grandis</i> ), by R. S. Hole . . . . .	0 4 0

## BULLETINS.

2. Memorandum on Teak Plantations in Burma, by F. A. Leete . . . . .	0 10 0
*8. Note on some Germination Tests with Sal Seed ( <i>Shorea robusta</i> ), by R. S. Troup . . . . .	0 2 0
*22. Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup . . . . .	0 5 0
*30. The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup . . . . .	0 2 0
*33. Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill . . . . .	1 0 0
*41. Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion . . . . .	0 8 0
*45. Note on the Miscellaneous Forests of the Kumaon Bhahar, by E. A. Smythies . . . . .	1 0 0
*46. Rate of Growth of Bengal Sal ( <i>Shorea robusta</i> ), I Quality, by S. H. Howard . . . . .	1 0 0
*47. Volume Tables and Form Factors for Sal ( <i>Shorea robusta</i> ), by the same author . . . . .	0 6 0
*58. General Volume Tables for Chir ( <i>Pinus longifolia</i> ), by S. H. Howard . . . . .	0 8 0
*62. Preliminary Yield Table for <i>Dalbergia sissoo</i> , by S. H. Howard . . . . .	0 2 0
*65. Tables for bark deductions from logs, by S. H. Howard . . . . .	0 3 0
*67. Chir ( <i>Pinus longifolia</i> ) Seed Supply, by S. H. Howard . . . . .	0 3 0
*78. The Problem of the Pure Teak Plantation, by H. G. Champion . . . . .	0 12 0
*82. The Measurement of Standing Sample Trees, by H. G. Champion . . . . .	1 2 0
*83. Provisional Yield Table for <i>Quercus incana</i> (Banj or Ban-oak), by H. G. Champion and L. D. Mahendru . . . . .	0 14 0
*86. Cold Weather Planting in Northern India, by H. G. Champion . . . . .	0 9 0
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*88. Seasonal Progress of Height Growth in Trees, by H. G. Champion . . . . .	0 14 0
*89. Effect of Defoliation on the increment of Teak Saplings, by H. G. Champion . . . . .	0 3 0
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**(PUBLICATIONS—PRINTED OUTSIDE INDIA.)**

- †Schlich's Manual of Forestry, Vol. I, 4th edition, 1922 . . . . . 7 8 0  
 †" " Vol. II, 4th edition, 1910 . . . . . 7 7 6  
 †" " Vol. III, 5th edition, 1925 . . . . . 14 1 0  
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*Forest Flora of the Chakrata, Dehra Dun and Saharanpur Forest Divisions, U. P., by Upendranath Kanjilal, Third Edition, revised and enlarged by Basant Lal Gupta . . .	3 3 0

## MANUALS.

*Manual of Botany, by R. S. Hole. (Reprinted) . . .	2 0 0
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## (PUBLICATIONS—PRINTED OUTSIDE INDIA.)

†Indian Trees, by Sir D. Brandis (1921 edition) . . .	35 0 0
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